SECOND TRIMESTER ANTENATAL UMBILICAL COILING INDEX AND ITS DOPPLER FLOW CHARACTERISTICS AND PERINATAL OUTCOME

PROSPECTIVE STUDY

DISSERTATION SUBMITTED TO

In partial fulfillment of the requirement for the degree of

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DEPARTMENT OF OBSTETRICS AND GYNAECOLOGY

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This is to certify that the dissertation entitled **"SECOND TRIMESTER UMBILICAL COILING INDEX AND ITS DOPPLER FLOW CHARACTERISTICS AND PERINATAL OUTCOME -PROSPECTIVE STUDY"** submitted by **Dr.Sharmila.S.Vandhana** to the Tamilnadu Dr. M.G.R Medical University, Chennai, in partial fulfillment of the requirement for the award of M.S. Degree Branch – II (Obstetrics and Gynaecology) is a bonafide research work carried out by her under direct supervision & guidance.

Prof. Dr.M.Sujatha, M.D.,O.G.,
Department of Obstetrics and Gynaecology,
Tirunelveli Medical College,
Tirunelveli- 627011.

Dr. Ramalakshmi, M.D., D.G.O.,
Professor and Head,
Department of Obstetrics and Gynaecology,
Tirunelveli Medical College
Tirunelveli- 627011.

CERTIFICATE

This is to certify that **"SECOND TRIMESTER ANTENATAL UMBILICAL COILING INDEX AND ITS DOPPLER FLOW CHARACTERISTICS AND PERINATAL OUTCOME -PROSPECTIVE STUDY".** presented here in by **Dr.Sharmila .S. Vandhana** is an original work done in the Department of Obstetrics and Gynaecology, Tirunelveli Medical College Hospital, Tirunelveli for the award of Degree of M.S. (Branch II) Obstetrics and Gynaecology under my guidance and supervision during the academic period of 2016 -2019.

The DEAN
Tirunelveli Medical College,
Tirunelveli - 627011.

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I solemnly declare that the dissertation titled **"SECOND TRIMESTER ANTENATAL UMBILICAL COILING INDEX AND ITS DOPPLER FLOW CHARACTERISTICS AND PERINATAL OUTCOME- PROSPECTIVE STUDY"** is done by me at Tirunelveli Medical College hospital, Tirunelveli. I also declare that this bonafide work or a part of this work was not submitted by me or any others for any award, degree, or diploma to any other University, Board, either in or abroad.

The dissertation is submitted to The Tamilnadu Dr. M.G.R.Medical University towards the partial fulfilment of requirements for the award of M.S. Degree (Branch II) in Obstetrics and Gynaecology.

Place: Tirunelveli
Date:

Dr.Sharmila .S.Vandhana
Postgraduate Student,
M.D Obstetrics and Gynaecology,
Department of Obstetrics and Gynaecology,
Tirunelveli Medical College
Tirunelveli.

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CERTIFICATE – II

This is certify that this dissertation work title **"SECOND TRIMESTER ANTENATAL UMBILCAL COILING INDEX AND ITS DOPPLER FLOW CHARACTERISTICS AND PERINATAL OUTCOME-PROSPECTIVE STUDY"** of the candidate **Dr.Sharmila.S.Vandhana** with registration Number **221616352** for the award of **M.S.** Degree in the branch of **OBSTETRICS AND GYNAECOLOGY (II).** I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion page and result shows **12% percentage** of plagiarism in the dissertation.

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91-462-2572733-EXT, 91-462-2572544, 91-462-2575765, 91-462-2572611-16
online@tvmc.ac.in, tirec@tvmc.ac.in; www.tvmc.ac.in

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PRINCIPAL INVESTIGATOR: POST GRADUATE STUDENT
DESIGNATION OF PRINCIPAL INVESTIGATOR: DR.SHARMILA S.VANDHANA, MBBS.,
DEPARTMENT & INSTITUTION: TIRUNELVELI MEDICAL COLLEGE, TIRUNELVELI

Dear Dr.SHARMILA S.VANDHANA, MBBS., The Tirunelveli Medical College Institutional Ethics Committee (TIREC) reviewed and discussed your application during The IEC meeting Held on 01.09.2017.

THE FOLLOWING DOCUMENTS WERE REVIEWED AND APPROVED

1. TIREC Application Form ☐
2. Study Protocol ☐
3. Department Research Committee Approval ☐
4. Patient Information Document and Consent Form in English and Vernacular Language ☐
5. Investigator's Brochure ☐
6. Proposed Methods for Patient Accrual Proposed ☐
7. Curriculum Vitae of The Principal Investigator ☐
8. Insurance /Compensation Policy ☐
9. Investigator's Agreement with Sponsor ☐
10. Investigator's Undertaking ☐
11. DCGI/DGFT approval ☐
12. Clinical Trial Agreement (CTA) ☐
13. Memorandum of Understanding (MOU)/Material Transfer Agreement (MTA) ☐
14. Clinical Trials Registry-India (CTRI) Registration ☐

THE PROTOCOL IS APPROVED IN ITS PRESENTED FORM ON THE FOLLOWING CONDITIONS

1. The approval is valid for a period of 2 year/s or duration of project whichever is later
2. The date of commencement of study should be informed
3. A written request should be submitted 3weeks before for renewal / extension of The validity
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7. The PI should report to TIREC within 7 days of the occurrence of the SAE. If the SAE is Death, the Bioethics Cell should receive the SAE reporting form within 24 hours of the occurrence.
8. In the events of any protocol amendments, TIREC must be informed and the amendments should be highlighted in clear terms as follows:
   a. The exact alteration/amendment should be specified and indicated where the amendment occurred in The original project. (Page no. Clause no. etc.)
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Dr.K.ShantaramanMD
Registrar, TIREC
Tirunelveli Medical College, Tirunelveli – 627011
State of Tamilnadu, South India

Dr.J.SureshDurai, MD
Member Secretary, TIREC
Tirunelveli Medical College, Tirunelveli – 627011
State of Tamilnadu, South India

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CONTENTS

INTRODUCTION

The umbilical cord is the essential lifeline of fetus supplying nutrients, oxygen and fluids necessary for life in utero. The trivascular conduit is well protected by Whartons jelly, amniotic fluid and the helical pattern or coiling of vessels.

Coiling makes the umbilical cord more flexible and strong and also provides resistance to the external force that could compromise the blood flow to the foetus. The coiling property of umbilical cord was first described by Berengarius in 1521 and first quantified by Edmonds in 1954[4]. The term umbilical cord coiling index was introduced by Strong et al. [6]

Coiling of umbilical cord and its blood flow pattern has been the subject of various anatomical and sonographic studies. These studies considered the development, structure of umbilical cord, its blood flow pattern and assessed utility of sonography to detect abnormal coiling and its blood flow pattern in utero as a marker of foetal compromise. A number of publications have appeared in the recent years about the abnormalities in cord coiling[10,11,12] .These studies have shown the relationship between abnormal umbilical cord coiling to adverse perinatal outcome. Very few studies have assessed blood flow characteristics utilizing Doppler ultrasound and its association with umbilical cord coiling index and perinatal outcome[21,22]. Since both hypocoiling and hypercoiling are associated with adverse perinatal outcome, we hypothesized

that abnormal coiling index may be associated with abnormal cord blood flow pattern and adverse perinatal outcome.

Abnormal umbilical cord coiling and abnormal umbilical cord blood flow pattern has been found to be associated with adverse perinatal outcomes like intrauterine death, increased interventional delivery, fetal distress and increased neonatal intensive care admissions[7,8]. Hence if the coiling index and its Doppler blood flow characteristics were measured antenatally, it would act as a predictor of adverse perinatal outcome.

This study was done to determine whether abnormal umbilical cord coiling patterns and its blood flow parameters measured sonographically between 20 to 28 weeks of gestation are associated with adverse perinatal outcomes.

REVIEW OF LITERATURE

The umbilical cord or the funiculus umbilicalis is essential for the survival and wellbeing of the developing foetus. This trivascular channel allows sufficient foetal blood to flow into and out from the placenta. It provides nutrients and oxygen necessary for life in utero. The cord comprising of an outer layer of amnion, a porous Whartons jelly, two umbilical arteries and one umbilical vein are designed to maintain the blood flow to developing foetus. Whartons jelly, amniotic fluid and helical pattern of coiling of the umbilical vessels protects the umbilical cord. Cord is the most vulnerable connection between the mother and the foetus susceptible to damage as it floats freely in the amniotic fluid.

Development:

Gastrulation, the most characteristic event occurring during the third week of gestation results in the formation of Trilaminar disc which consists of three germ layers namely Ectoderm, Mesoderm and Endoderm[(1)]. The first germ layer to be formed is Endoderm followed by Ectoderm and lastly Mesoderm. A cavity appears on the ectodermal side of the disc which is called the amniotic cavity. Another cavity called the primary yolk sac develops on the endodermal side. The trophoblast and underlying somatopleuric mesoderm (extra embryonic mesoderm) form a membrane called the Chorion. The cells forming wall of the cavity forms the amnion. Once the extraembryonic coelom is formed, the yolk sac becomes smaller in size and is lined by cubical cells and is referred to as

Secondary yolk sac. There occurs a progressive increase in the size of the embryonic disc. This increase in length results in its bulging into the amniotic cavity. With further enlargement, the embryonic disc folds on itself at cranial and caudal ends – referred to as head and tail folds.

The developing embryo along with amniotic cavity and yolk sac is suspended in the extra embryonic coelom and is attached to the wall of blastocyst by a thin un split part of extra embryonic mesoderm which later forms a structure called Connecting stalk. Connecting stalk is the only connection between the embryo and the placenta and its attachment becomes relatively smaller as the embryo grows and is seen only near the caudal end. With the formation of tail fold, the attachment of connecting stalk moves to the ventral aspect of the embryo and is now attached in the region of umbilical opening.

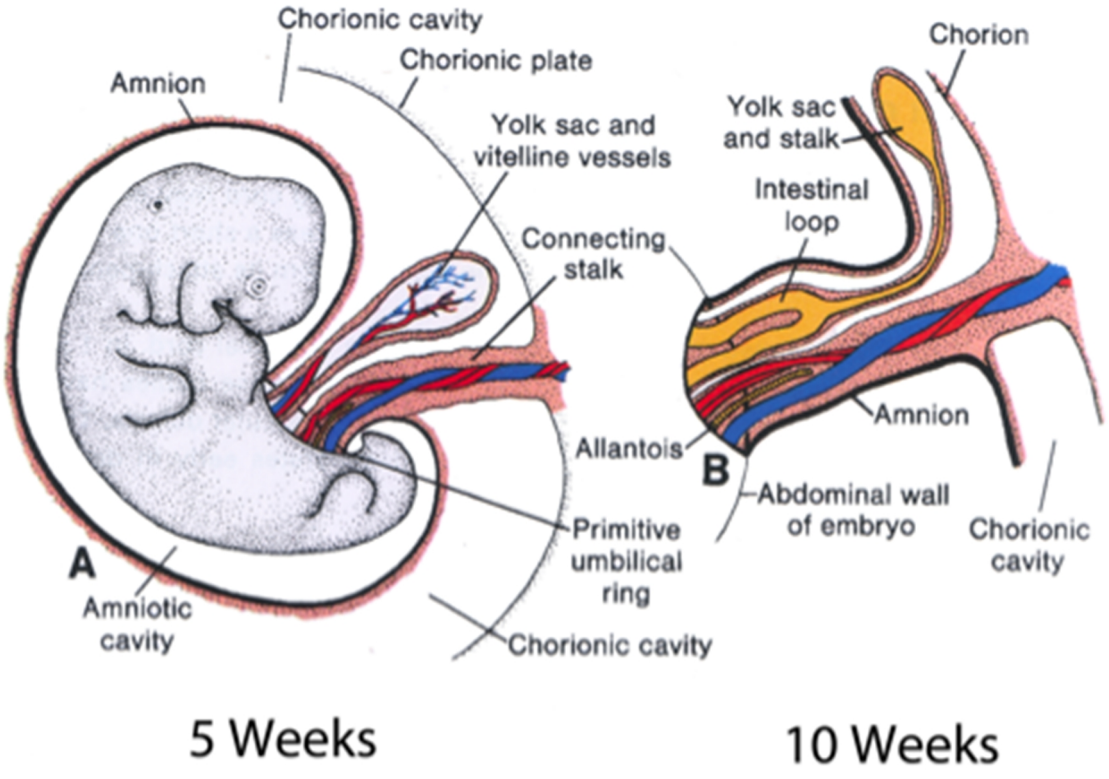


Figure 1 Development of umbilical cord at 5 weeks and 10 weeks of gestation

By now blood vessels have developed in the embryo and placenta which are interconnected by two arteries and two veins present in the connecting stalk. Later right vein disappears. At this stage, the amnion has a circular attachment to the margins of umbilical opening and forms a wide tube which contains:

1. Vitellointestinal duct and remnants of the yolk sac.

2. Whartons jelly

3. Blood vessels: 2 arteries and one vein

4. A small part of extra embryonic coelom

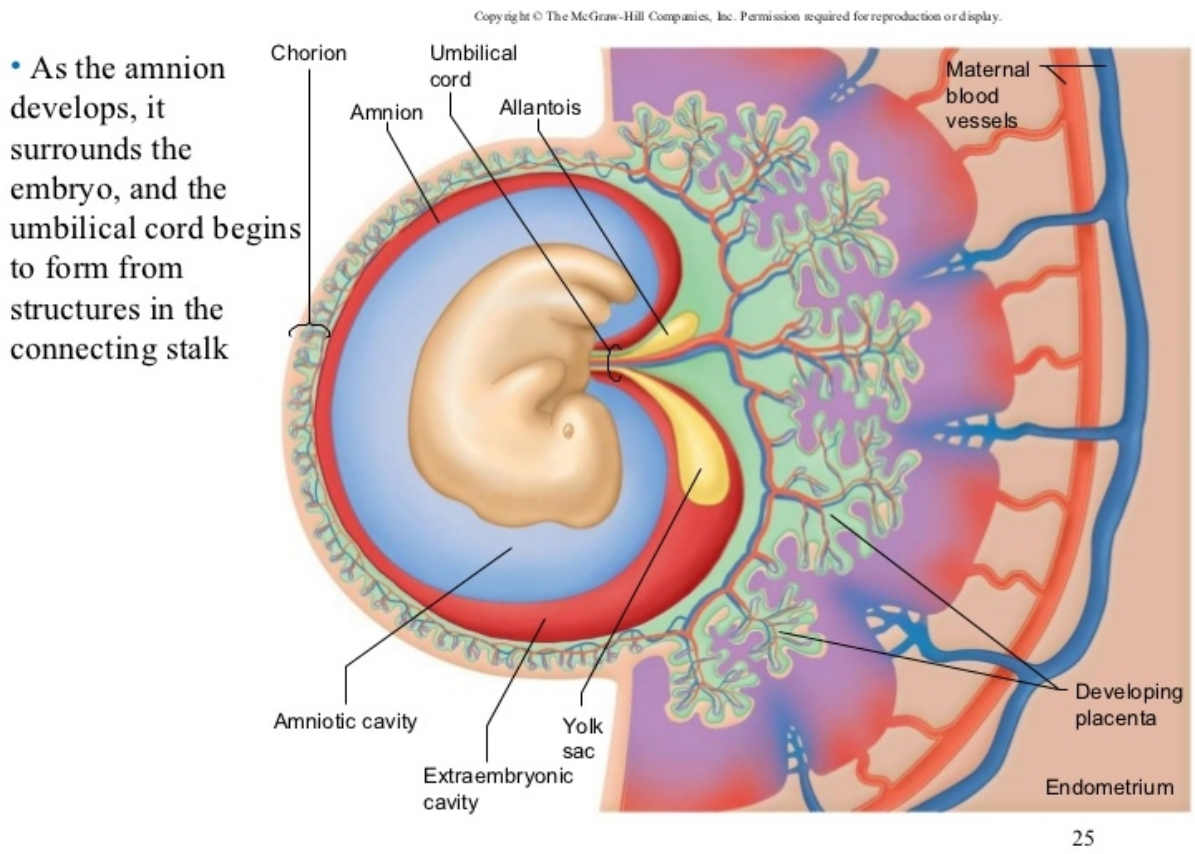


Figure 2 Development of umbilical cord

This tube of amnion and the structures within it constitute the umbilical cord. The cord progressively increases in length. Growth of umbilical cord parallels with the growth of foetus till 28 weeks; then umbilical cord attains a mean circumference of 2 cm and a length of 55 cm.

By the 10th week, the developed gastrointestinal tract protrudes through the umbilical ring to form the physiological normal herniation into the umbilical cord. Normally these bowel loops retract by 3rd month. The coiling of cord starts by 28 days of gestation. The umbilical cord is visualized in USG by 42 days of

gestation and well established by 8-9 weeks of gestation and appears as twisted rope like echogenic structure[2].

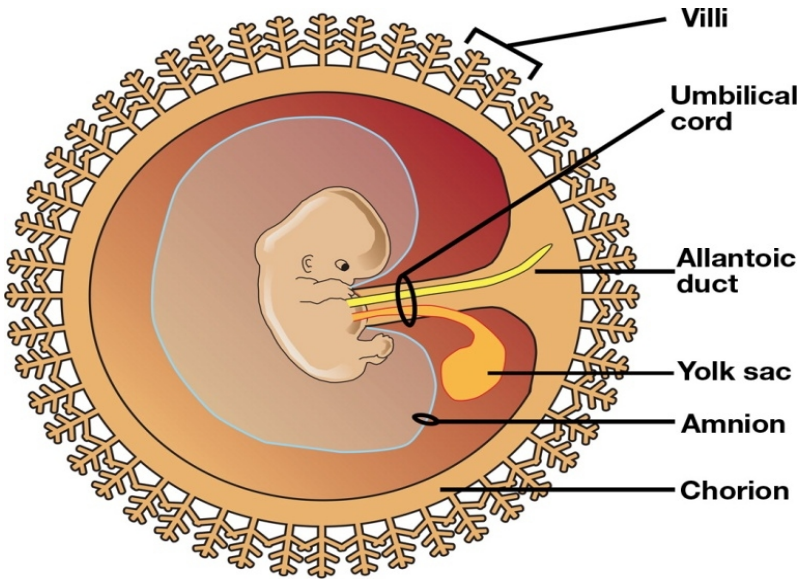


Figure 3 Umbilical cord development with allantois

Foetal Circulation

Oxygenated blood from the placenta reaches the fetus through the umbilical vein which joins the left branch of portal vein. Through the ductus venosus, major portion of blood passes through the inferior vena cava and minor portion through the substance of liver into the inferior vena cava.

Most of the oxygenated blood reaches the right atrium through the inferior vena cava and pass through the foramen ovale into the left atrium, the rest of the blood gets mixed up with the deoxygenated blood from the superior vena cava and passes into the right ventricle[1]. From the right ventricle blood enters pulmonary trunk, most of which is deoxygenated. Only a small portion of this blood reaches the lungs from where it passes into the left atrium. Major

portion of the blood passes via the ductus arteriosus into the aorta. So the blood in left atrium is rich in oxygen and passes into the left ventricle from where it reaches the aorta. Some portion of this oxygen rich blood reaches the brain, the head and neck and the upper extremities through the carotid and the subclavian arteries. Rest of the blood gets mixed up with poorly oxygenated blood from ductus arteriosus. So those parts of the body supplied by branches of aorta arising distal to its junction with the ductus arteriosus receive blood with moderate oxygen.

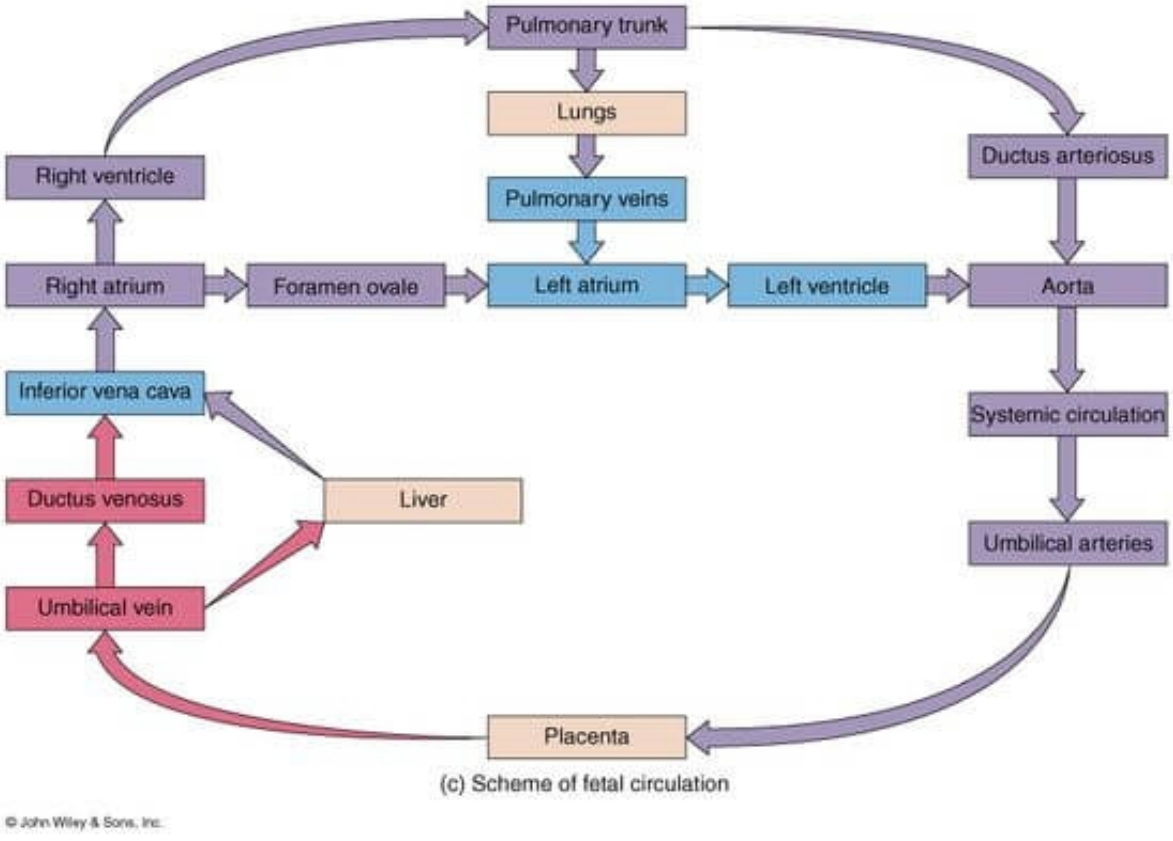


Figure 4 Foetal circulation before birth

Changes in circulation at birth

Soon after birth several changes occur in the fetal circulation which leads to establishment of adult type of circulation.

1. Muscles in the wall of umbilical arteries contract immediately after birth leading to occlusion of their lumen which prevents the loss of fetal blood to placenta.

2. The lumen of umbilical vein and ductus venosus also get occluded, but few minutes after birth. This provides enough time for the fetal blood that's in the placenta to drain back into the fetus.

3. The ductus arteriosus also get occluded so that blood from right ventricle now reaches the lungs where it is oxygenated.

4. There occurs an increase in size of pulmonary vessels which causes a larger volume of blood to reach the left atrium from the lungs which in turn results in an increase in pressure within the left atrium. At the same time pressure in the right atrium is decreased because blood from the placenta no longer reaches right atrium. All these changes result in an increase in pressure within the left atrium compared with right atrium, causing closure of foramen ovale.

The occluded vessels in course of time are replaced by fibrous tissue resulting in formation of various ligaments. Umbilical arteries form the medial umbilical ligaments. Left umbilical vein forms the ligamentum teres. Ductus

venosus forms ligamentum venosum and ductus arteriosus forms the ligamentum arteriosum.

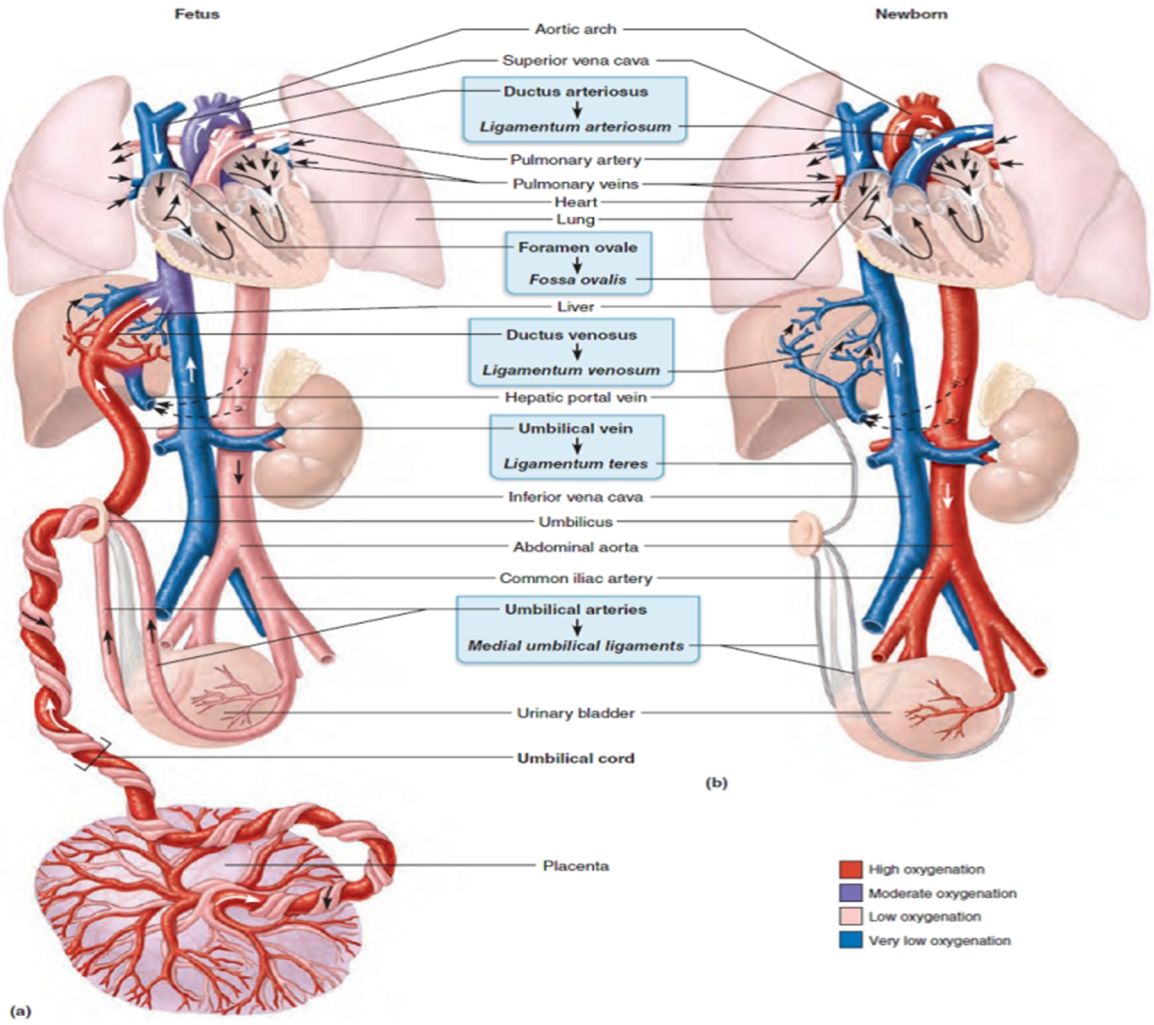


Figure 5 Foetal circulation after birth

Morphology of umbilical cord

At term a normal umbilical cord is about 50-60 cm in length and range varies between 30 to 100 cm. The average diameter is around 2 cm and varies between 1 to 2.5 cm. Umbilical cord appears to be moist and is dull white in colour. The

umbilical cord vessels are entrenched within a proteoglycan rich matrix known as Whartons jelly surrounded by a thin layer of amnion[3]. Whartons jelly was named after Thomas Wharton (1614-1673), an English physician who first described it. Whartons jelly cushions the umbilical vessels and thus prevents disruption of blood flow due to compression or bending caused by foetal movement and uterine contraction. Whartons jelly is metabolically active throughout the pregnancy and is composed of an interconnecting cavity and canalicular structures that facilitates transfer of water and metabolites between amniotic fluid and umbilical blood vessels.

Helical course of the arteries around the vein determines the characteristic structure of the umbilical cord. There are usually 10 to 11 coils between the fetal umbilical ring and the placental insertion. Umbilical cord is a dynamic structure and its morphology is influenced by a number of factors like - amount of amniotic fluid and its composition, gestational age, foetoplacental haemodynamics and maternal conditions complicating pregnancy.

Characteristic features of umbilical cord vessels

The cord contains two umbilical arteries and one umbilical vein. The walls of umbilical arteries lack internal and external elastic lamina and are replaced by mucous connective tissue. The umbilical vein possess a thickened muscular layer with inter mingling oblique, circular, longitudinal smooth muscle fibers as well as internal elastic lamina. The tunica media of these vessels contain inter decussating helicoidal smooth muscle bundles instead of the usual

circular longitudinal fibers. The vascular tone of vessels is modified by prostaglandins. These vessels are devoid of nerve fibers and vasa vasorum. The outer surface of umbilical arteries have furrows knows as inner folds of Hoboken and it alternates with dilated nodes of Hoboken. During spasm these structures occlude the vessels and provide intrinsic capacity to control bleeding.

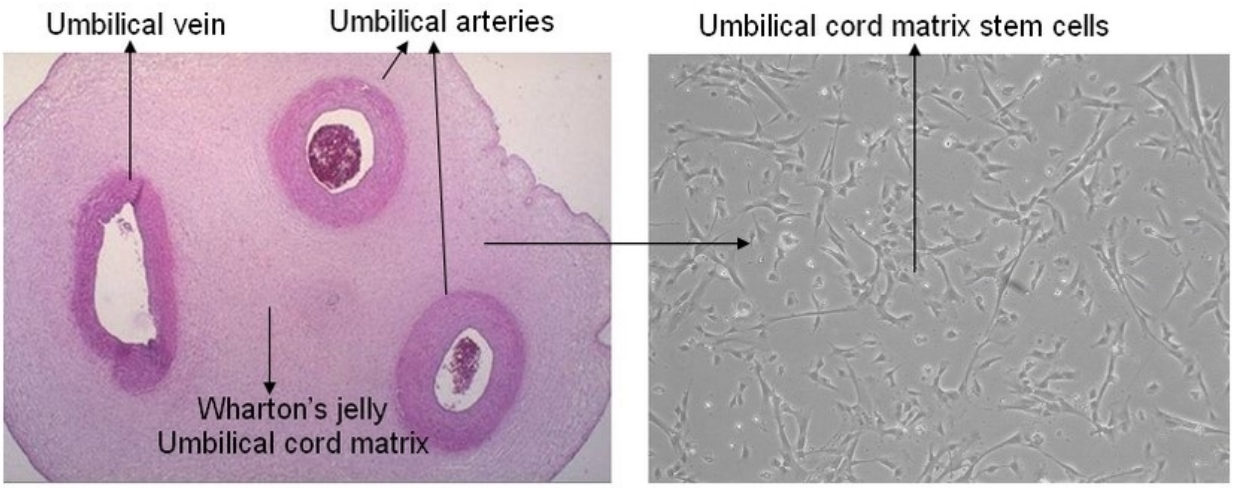


Figure 6 Morphology of umbilical cord vessels

Special features of umbilical vein

The umbilical vein pressure increases from 4.5mmHg at 18 weeks to 6mmHg at term[20,25]. The area of vein is 30% larger than combined area of arteries so the velocity of blood flow is half as slow as velocity in either arteries[19]. Blood flow through the umbilical vein is due to pressure gradient during the cardiac cycle leading to decreased preload allowing blood from the umbilical vein to reach the heart. The pressure gradient changes occurring during fetal breathing movements also alter the blood flow such that the velocity of blood flow increases during inspiration.

Coiling of cord

Coiling property was first described by Berengarius in 1521. A coil is described as complete 360 degree of spiral course of umbilical vessels around Whartons jelly. In1954 Edmonds et al[4] first quantified the umbilical coiling by dividing the number of coils by umbilical cord length and called it as “THE INDEX OF TWIST". He also postulated that umbilical cord coiling occurred as a result of rotatory movement imparted to the embryo. Coiling can be either clockwise (right sided) or anticlockwise (left sided). Studies have shown that left sided coiling (85%) is more common than right sided coiling (15%) with a ratio of 7:1[2,5]. Handedness was believed to be a factor that determines the direction of coiling because the ratio of right handed to left handed people in the world is roughly 7:1, which is same as the ratio of anticlockwise to clockwise coiling of umbilical cord. Later Strong et al eliminated the Bidirectional scores and named it “THE UMBILICAL CORD COILING INDEX”[6].

According to Simpson, twisting of umbilical cord occurred as a result of rotational torque which leads to differential blood flow between the left and right umbilical arteries.

Coiling makes the cord more flexible, strong and provides resistance against external force that could compromise blood flow to fetus[7].

Mechanism of coiling of umbilical cord is largely unknown; whether it is a genetically determined or an acquired phenomenon is still a subject of debate.

Various hypothesis have been postulated to explain the origin of umbilical cord coiling which includes

- Fetal movement

- Fetal hemodynamic forces

-Genetic factors

- Umbilical vascular wall mechanism

- Arrangement of muscle fibers (roach muscle fibers) in the umbilical arterial wall

-Differential umbilical vascular growth rate.

Right umbilical artery is larger than left umbilical artery and so left sided twisting is more common.

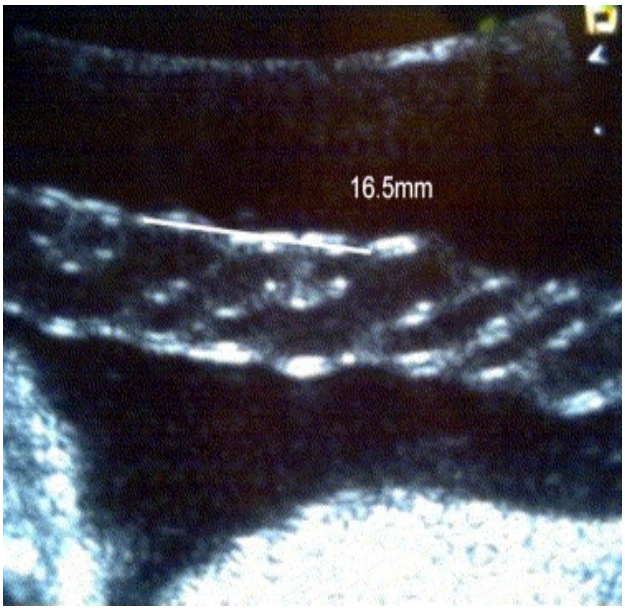


Figure 7 Umbilical cord coiling

Umbilical cord coiling index

Umbilical cord coiling index is defined as the number of coils in the umbilical cord divided by the total length of the cord.

1/ distance in cm

The normal coiling pattern is the rate of 1coil per 5cm which equates to a coiling index of 0.2/cm. The total number of coil becomes constant in the first trimester by around 8 weeks whereas the length of cord continues to grow. So umbilical cord coiling index decreases as the gestational age increases. The rate of growth of umbilical cord length is about 3cm to 6 cm per month and the growth rate is more in the second half of pregnancy. So the coiling index in the third trimester is less than that in the second trimester. The rate of lengthening of cord varies from individual to individual and so does the umbilical cord index.

The length of umbilical cord cannot be measured antenatally. Hence a method was devised to measure the coiling index antenatally using ultrasonogram. Antenatal UCI INDEX is calculated as reciprocal value of distance between adjacent pair of coils measured in cm from inner edge of arterial or venous wall to outer edge of next coil along the ipsilateral side. Average of 3 readings at 3 different segments in the free floating cord is the final value.

1/distance in cm between adjacent pair of coils

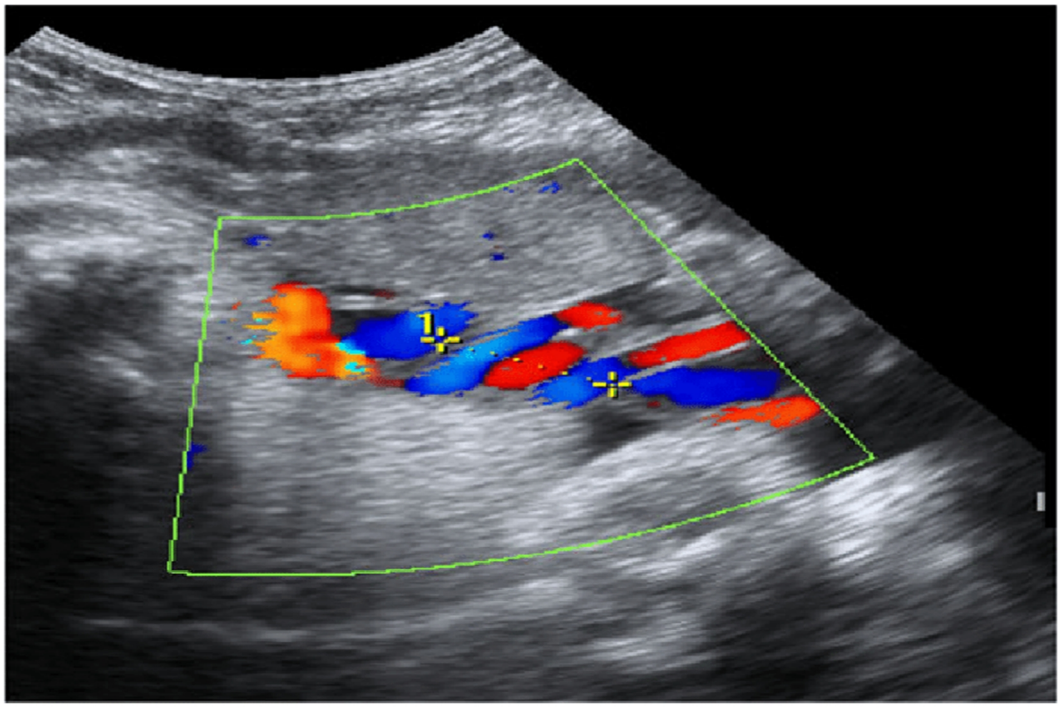


Figure 8: Color Doppler ultrasound of the umbilical cord . Umbilical coiling index is measured from the inner edge of an artery to the outer edge of the same artery at the adjacent umbilical twist along the ipsilateral cord side.

Cord coiling index less than 0.1 /cm is considered as hypocoiled and more than 0.3 /cm is considered hypercoiled. A frequency of distribution of umbilical coiling UCI done by Rana et al[8] concluded that:

<10th percentile	Hypocoiled
10-90th percentile	Normocoiled
>90th percentile	Hypercoiled

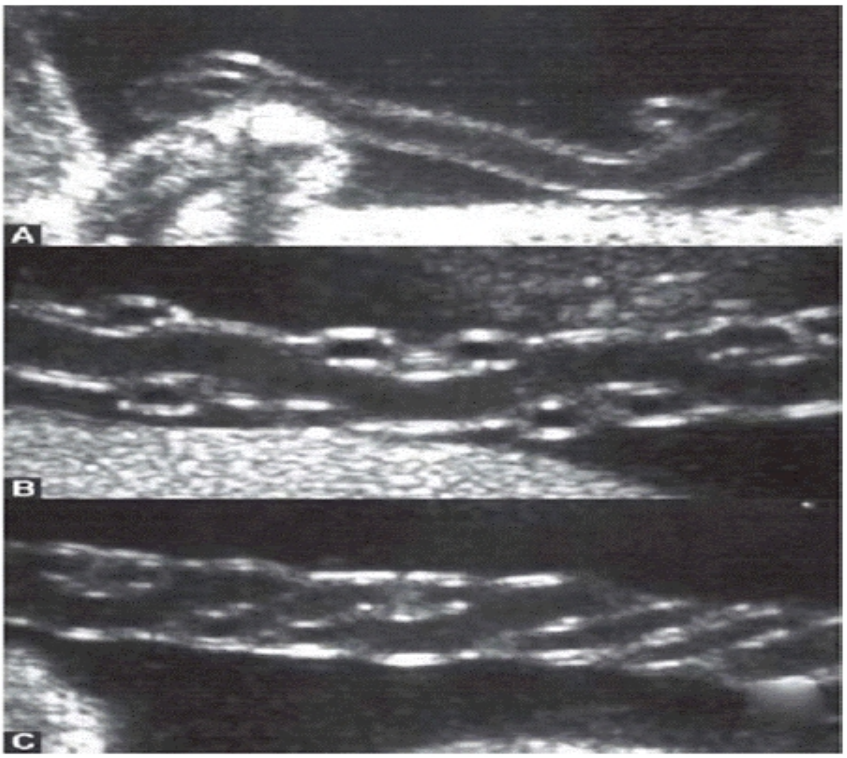


Figure 9: A NORMOCOILED; B HYPOCOILED; C HYPERCOILED

Umbilical cord thickness depends upon the vessel luminal diameter and amount of Whartons jelly. UCI is not related to umbilical cord thickness. Cross sectional area of umbilical cord is calculated in the transverse section in free floating portion of the cord.

Cross sectional area < 10^{th} percentile: Lean cord

Cross sectional area >90^{th} percentile: Large cord

There have been only a very few studies in literature which assessed the association between antenatal sonographic umbilical cord coiling index and its perinatal outcome. Some studies conducted in the early second trimester (14 to 16 weeks) showed that hypocoiling was associated with fetal growth restriction

(FGR) but no association was seen with preterm birth, low APGAR or abnormal fetal heart rate patterns. But certain studies conducted in the mid second trimester (18 to 23 weeks) showed that hypocoiling and hypercoiling were associated with FGR and abnormal heart rate patterns[9,10,11,12]. Some studies conducted in the late second trimester (22 to 28 weeks) came to the conclusion that hypocoiling is associated with FGR, preterm birth, LBW and low APGAR[13,14,15]. Few studies have shown that lean cord is associated with hypocoiling, reduced venous blood flow and reduced amount of Whartons jelly[16,18,25,27].

Umbilical blood vessel flow characteristics

Reynolds et al postulated that the umbilical cord is a trivascular pistonless pulsometer pumping system that acts as a cardiac assist pump to sustain venous return to placenta[19]. Umbilical blood flow occurs as a result of decrease and increase in venous pressure that are generated from the force of rising limb of arterial pulse pressure. The presence of arterial coil around the vein along the length of the cord provides multiple variations. In additive fashion these vascular coils play a central role in determining blood flow from placenta to fetus. This mechanism is very important in early gestation, when there is more coiling and hence more the blood flow, even though placental resistance to blood flow is partially elevated[23].

According to Poiseuilles law, three factors that influence the blood flow are viscosity of blood, caliber of the vessel and blood flow velocity[20]. Therefore a

hypocoiled /uncoiled cord leads to decreased blood flow causing fetal growth impairment and making it susceptible to external compression[18]. Hypercoiling causes relative increase in resistance at the level of umbilical cord ring causing congestion of extra abdominal umbilical vein and also increased turbulence in arteries, all of which leads to a decrease in both arterial and venous flow.

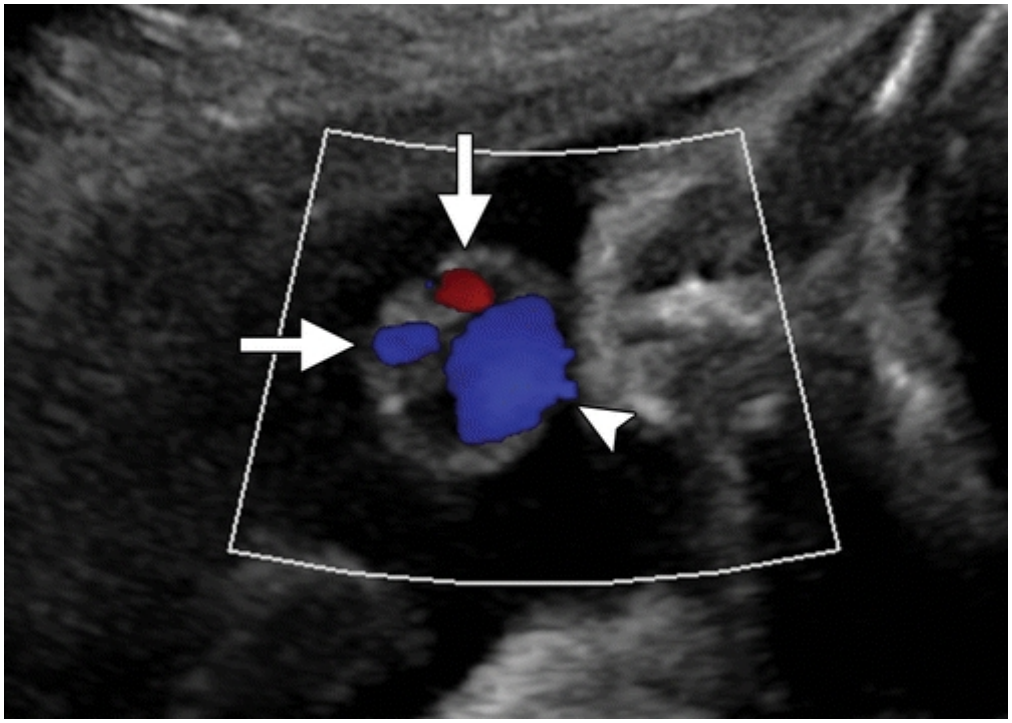


Figure 10 Umbilical cord vessels

Weissman and Raio reported normograms for the diameter of umbilical vessels showing that diameter of the vessels progressively increases and gradually plateaus[21].

Degani et al found significant relationship between sonographic UCI and doppler flow characteristics in the umbilical vein. Both hypo and hypercoiling were associated with adverse perinatal outcome[22]. Barbera demonstrated that

umbilical vein blood flow for estimated foetal weight does not change significantly from 20 weeks of gestation to term[23,24].

Doppler blood flow of the umbilical cord

Umbilical vessel blood flow characteristics are studied by doppler velocimetry. Before 20 weeks of gestation, the umbilical artery demonstrates high resistance flow on spectrometry and with advancing age the resistance to flow decreases. The umbilical artery has a characteristic saw toothed appearance of arterial flow in one direction whereas umbilical vein blood flow is continuous[29]. These waveforms reflect the fetal cardiac cycle. The Doppler frequency increases as the Doppler ultrasound beam becomes more aligned to the flow direction (Angle of isonisation which is the angle between beam and direction of flow). The Doppler sampling site near the foetal end of the cord shows a high impedance flow and the portion close to placental end shows poor wave, so free floating portion of cord is chosen to measure the indices.

The Commonly measured indices in the umbilical arteries:

- PEAK SYSTOLIC VELOCITY (PSV)
- END DIASTOLIC VELOCITY(EDV)
- RESISTANCE INDEX(RI): PSV-EDV/PSV
- SYSTOLIC - DIASTOLIC RATIO(S/D): PSV/EDV
- PULSATILITY INDEX(PI): PSV-EDV/Time averaged maximum velocity

Umbilical vein blood flow measured in ml/min.

Umbilical Vein blood flow wave forms are altered during the fetal respiration - increases with inspiration and decreases with expiration.

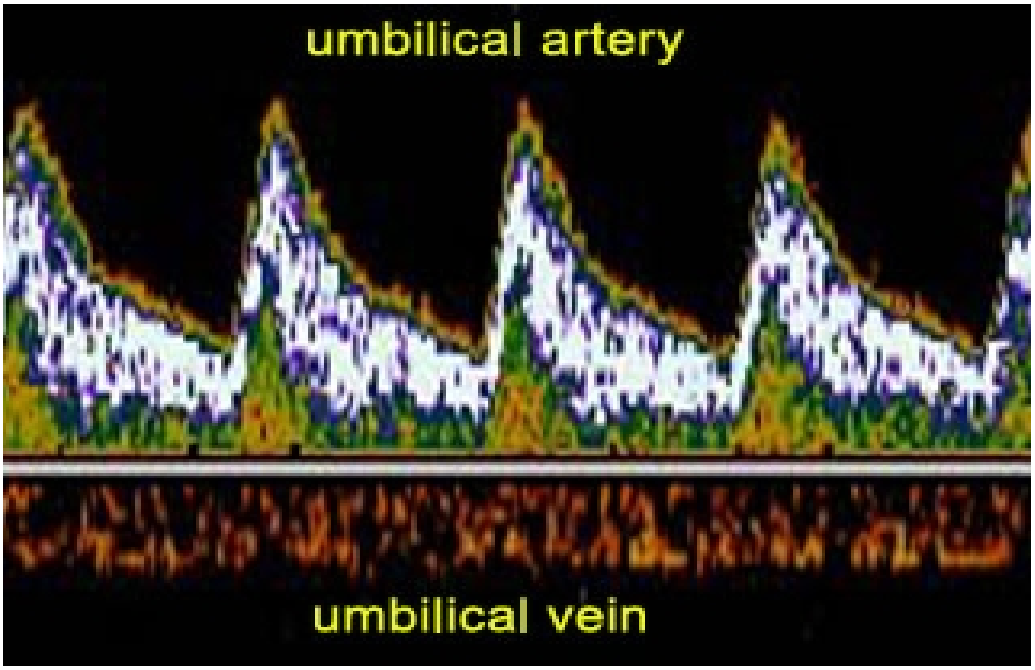


Figure 11 Doppler blood flow characteristics of umbilical cord

Abnormalities of cord

1. Morphological abnormalities

Short cord:

Short cord is defined as length of the umbilical cord less than 35 cm and is associated with congenital anomalies, abnormal heart rate pattern, hypokinetic baby, abruption, cord rupture and delayed descent of the baby. There can be relative shortening of cord due to entanglement[(26)].

Long cord:

Long cord is defined as length of cord more than 70cm and is associated with cord entanglement, true knot, cord prolapse and hyperkinetic baby.

Lean cord:

Lean cord (cross sectional area <10^{th} percentile) is associated with small for gestational age, fetal distress, abnormal heart rate pattern and increased operative deliveries.

Large cord:

Large cord (cross sectional area > 90^{th} percentile) is associated with increased risk of aneuploidies. Large cord occurs due to excess of polysaccharides and proteoglycans leading to increased fluid collection.

2. Vascular abnormalities

Single umbilical artery (SUA)

It is the most common umbilical cord anomaly with an incidence of 1%. It's present in nearly 0.85% of normal pregnancies and is usually associated with maternal diabetes, pre eclampsia and epilepsy. Either there may be a congenital absence of umbilical artery described as agenesis or a poorly developed umbilical artery termed as hypoplastic / missing / atrophy of vessel. SUA may be associated with congenital anomalies or can be isolated SUA without any

defects. Single umbilical artery is associated with genitourinary anomalies (16%), aneuploidy (28%), LBW 25 -29% and FGR 34%.

Persistant right umbilical vein

This is due to altered development of cord between 4^{th} to 7^{th} weeks of gestation and it occurs in 0.1-0.3% of pregnancies. This leads to abnormal course of blood flow in the fetal liver. It is associated with genitourinary abnormalities, gastrointestinal, cardiac and skeletal developmental abnormalities.

Aneurysm

Umbilical vein aneurysm is the dilatation of the vein with cord diameter more than 8 mm causing increased venous pressure. Its etiology is unknown and is a rare finding commonly associated with chromosomal abnormalities.

Haematoma

This occurs due to rupture of varix of umbilical vein. It is more common during in utero invasive procedures and causes acute fetal distress.

3. Cord masses

Haemangioma

Haemangioma occurs due to the proliferation of primitive angiogenic mesenchyme cells seen as hyper echogenic area in the main cord. It is associated with chromosomal anomalies and MSAF.

4. Cord insertion abnormalities

Two most common type of cord insertion anomalies are velamentous insertion and marginal insertion. Velamentous insertion occurs in 8.7% of twin gestations and 1.1% of singleton pregnancies. Here the cord inserts in chorioamniotic membrane and is associated with cord compression, preterm labour, placental abruption, low APGAR and abnormal fetal heart rate pattern. In Marginal insertion or Battledore placenta, cord is attached to the margin in 5-7% of pregnancies. Marginal insertion has a high prevalence in multiple pregnancy and leads to unequal placental sharing.

5. Lesions of cord

True cord lesions include urachal, allantoic or omphalomesentric duct, hemangioma, hematoma, pseudocyst or mucoid degeneration of Whartons jelly. Pseudocord lesions are omphalocele and gastrochisis.

6. Knots

Its incidence is 1%. Knots can be true knot or false knot. True knot is due to increased fetal movements and seen more in mono amniotic twins and can lead to fetal loss. False knot is more common due to kink in the umbilical cord vessel and has no significance.

7. Cord strictures

It is the constriction or occlusion of cord due to decreased amount of Whartons jelly. Strictures cannot be diagnosed antenatally and its etiology is unknown and can lead to still birth.

8. Cord remnants

Remnant of yolk sac is seen as a small yellow body near the attachment of cord to the placenta. Meckels diverticulum is the persistence of proximal part of vitellointestinal duct. Exomphalos is the persistence of herniation of coils of umbilical cord. True /false cyst of umbilical cord is the remnant of allantois. It is associated with hydronephrosis, urachus and omphalocoele[26].

STUDIES ON UMBILICAL CORD COILING INDEX AND BLOOD FLOW

Predanic et al, in the year 2005, performed routine foetal anomaly scan among 425 consecutive women in the second trimester between 18 to 23 weeks of gestation and studied the antenatal umbilical cord coiling index. Among the women studied, only 294 antenatal women had adequate data regarding obstetrics ultrasound, labour and other intrapartum events. The distance between a pair of coils was measured and its reciprocal was taken as the umbilical cord coiling index. The index thus calculated was correlated with various adverse pregnancy outcomes like small for gestational age, mode of delivery, presence of meconium-stained amniotic fluid, non-reassuring foetal heart rate patterns during

labour and Apgar scores at 1 and 5 minutes. The study showed abnormal coiling index in 58 patients among whom 15 patients (25.7%) had non reassuring foetal heart rate patterns during labour and 9 patients (15.5%) gave birth to small for gestational age babies.

In contrast, there was no correlation between umbilical cord coiling index and Apgar scores at 1 and 5 minutes, mode of deliver or presence of meconium-stained amniotic fluid in labour. The conclusion of the study was that abnormal umbilical cord coiling in the second trimester is associated with a higher prevalence of small for gestational age neonates and non reassuring foetal heart rate patterns in labour.

J.Rana et al in 1994, examined placentas from 635 deliveries occuring beyond 24 weeks gestation and studied the umbilical cord coiling pattern. Rate of fetal heart rate (FHR) disturbances and interventional delivery were higher in the hypocoiled group (28.6 % versus 15.9% [P =.01] and 19 % versus 7.1% [P =.002], respectively). The subjects with hypercoiled cords compared with those found to have normocoiled cords had a higher rate of premature delivery (33.3% versus 12.0% [P =.0006]). Conclusion was that hypocoiled cords could be predictors of potential interventional delivery and intrapartum FHR disturbances whereas hypercoiled cords were associated with an increased incidence of premature delivery and maternal cocaine use.

In a prospective study by De Laat M W in 117 pregnancies, the antenatal UCI was measured beyond 28 weeks of gestation by ultrasonography. The

postnatal UCI (pUCI) was calculated as the number of coils divided by the cord length in cm. The correlation between aUCI and pUCI was assessed and likelihood ratios for adverse pregnancy outcome were calculated. Study concluded that hypocoiling of the cord had greater association with fetal demise, intrapartum fetal heart rate decelerations, operative delivery, anatomic-karyotypic abnormalities and chorio-amnionitis. Hypercoiling of the cord had greater association with fetal growth restriction, intrapartum fetal heart rate decelerations, vascular thrombosis and cord stenosis.

Degani et al studied 45 normal term fetuses in the laast 24 hours before delivery. The umbilical coiling index was determined using ultrasound and doppler flow velocities were obtained from umbilical vessels. Flow characteristics were correlated with the umbilical coiling index. The mean (+/- standard deviation) umbilical coiling index was 0.44 +/- 0.11 in the antepartum period and 0.28 +/- 0.08 after birth. The correlations between sonographic coiling index and umbilical arterial Doppler flow characteristics (mean velocity, pulsatility index, resistance index, and systolic-diastolic ratio) were not significant. The sonographic coiling index was related to time-averaged velocity and flow in the umbilical vein. A good correlation was found between umbilical vein flow and the coiling index, with a significant linear trend ($r = 0.59$, $P < .001$). Conclusion was that intrauterine umbilical coiling index determined by ultrasound correlates well with the actual index at birth. The sonographic

umbilical coiling index is related to Doppler flow characteristics in the umbilical vein.

Predanic et al recorded umbilical coiling patterns and blood flow characteristics in 200 consecutive pregnant patients in second trimester between 18-23 weeks' gestation. The mean antenatal UCI was 0.40, with 10th and 90th centiles of 0.20 and 0.60, respectively. The mean +/- SD umbilical artery RI and PSV and umbilical vein blood flow volume were 0.74 +/- 0.07, 25.1 +/- 6.4 cm/s, and 264 +/- 106 mL/min/kg, respectively. All Doppler variables correlated significantly with antenatal UCI, with lower RI and higher PSV and umbilical vein blood flow volume values being associated with higher antenatal UCI ($P = 0.016$, $P < 0.001$, and $P = 0.032$, respectively). However, when stratified by antenatal UCI into hyper- (above 90th centile), normo- (10th-90th centile), and hypocoiled (below 10th centile) umbilical cord groups, a significant difference was observed for PSV only ($P = 0.016$). It was concluded that more prominent umbilical coiling (higher antenatal UCI values) had a protective effect on blood flow in terms of decreased arterial resistance and higher blood flow velocities, as well as increased venous blood flow. However, due to lack of significant differences between Doppler characteristics when stratified by antenatal UCI into hypo-, normo-, and hypercoiled groups, the clinical implications of this observation were uncertain.

De Nairo et al studied 116 consecutive women with a singleton gestation who delivered at term and who underwent an ultrasound examination within 24

hours from delivery. After delivery, the umbilical coiling index was calculated. Twelve (10.3%) cases had a lean umbilical cord (area < 10th centile). A significant correlation was found between the umbilical coiling index and the umbilical vein blood flow ($r = 0.67$, $P < 0.001$). A significant difference between fetuses with and without a lean cord was found in terms of umbilical coiling index (0.18 ± 0.08 vs. 0.29 ± 0.09, $P < 0.005$), cord area (87.6 ± 5.1 mm^2 vs. 200.6 ± 34.6 mm2, $P < 0.001$), Wharton's jelly amount (25.7 ± 10.3 mm2 vs. 122.1 ± 33.4 mm2, $P < 0.001$), umbilical vein blood flow (93.7 ± 17.8 ml/kg per min vs. 126.0 ± 23.4 ml/kg per min, $P < 0.001$), and umbilical vein blood flow mean velocity (6.6 ± 2.7 cm/s vs. 9.0 ± 3.6 cm/s, $P < 0.05$). The proportion of fetuses with an umbilical vein blood flow < 80 ml/kg per min was higher when the cord was lean than when it was normal (25% vs. 1.9%, $P < 0.01$). Conclusion of the study was that lean umbilical cords differ from normal cords not only from a structural point of view but also in the umbilical vein blood flow characteristics. This could explain the increased incidence of intrapartum complications and foetal growth restriction among foetuses with a lean and/or hypocoiled cord.

Mana et al studied about the effect of umbilical vein blood flow on perinatal outcome of fetuses with lean and/or hypo-coiled umbilical cord. They evaluated the effect of umbilical vein (UV) blood flow measured by colour directed pulsed wave Doppler on perinatal outcome of fetuses with lean and/or

hypocoiled umbilical cord after 24 weeks of gestation in 244 women with singleton fetus after 24 weeks of gestation. Umbilical cord area, umbilical vessel cross-sectional area and antenatal umbilical coiling index (UCI) were calculated and compared with Doppler parameters including UV blood flow volume in ml/min/kg, UV peak systolic velocity in cm/s, and umbilical artery pulsatility index. Conclusion of the study was that foetuses with lean and/or hypocoiled umbilical cord showed a noticeable decrease in UV blood flow of sufficient magnitude that could affect foetal growth and this could explain the higher prevalence of foetal intrapartum complications in growth-restricted foetuses.

Yung Sung Jo in his retrospective study of 251 pregnancies, calculated UCI at 22-28 weeks gestation. The subjects were divided into normocoiled, hypocoiled and hypercoiled groups and perinatal outcome was compared. The incidence of preterm deliveries in hypocoiled group was 35%, which was significantly greater than the normocoiled groups (p=0.041). The incidence of neonates with low birth weights in the hypocoiled group was 36.4%, which was significantly greater than the normocoiled groups (p=0.044). In the hypocoiled group, 27.3% of newborns were admitted to the NICU which was significantly greater than the normocoiled and hypercoiled groups (p=0.041. Thus it was observed that hypercoiling of the umbilical cord during the late second trimester of pregnancy was associated with high risk of preterm delivery and low birthweight and the admission to the neonatal intensive care unit was increased.

Machin G A in his study of 1329 cases referred for placental pathology services, noticed that 21% of cords were overcoiled and 13% were undercoiled. Principal clinical correlations found in overcoiled cords were foetal demise (37%), foetal intolerance to labour (14%), intrauterine growth retardation (10%), and chorioamnionitis (10%). For undercoiled cords, the frequencies of these adverse outcomes were 29%, 21%, 15%, and 29%, respectively. Abnormal cord coiling was associated with thrombosis of chorionic plate vessels, umbilical venous thrombosis, and cord stenosis.

Ercal T prospectively studied relationship between the number of coils in the umbilical cord and perinatal outcome in 147 live born neonates. The mean UCI was 0.20 +/- 10 (SD). Hypocoiled cord had higher incidence of meconium staining, interventional delivery, Apgar scores, foetal blood pH and intrapartum foetal heart rate disturbances. He concluded that the UCI had a strong relationship with perinatal outcome and may be used antenatally as a marker for identifying the foetus at risk

In a prospective study of 470 patients with singleton pregnancies by Predanic M, he evaluated relationship between the umbilical cord thickness and cord coiling patterns during the fetal sonographic anatomic survey in the second trimester between 18 to 23 weeks. The mean aUCI was 0.41 with 10th and 90th percentiles of 0.21 and 0.60, respectively. A total of 10.6% (34/321) and 9.3% (30/321) of patients were categorized as having hypocoiled and hypercoiled umbilical cords, respectively. The mean cord diameter +/- SD was 9.48 +/- 0.97

mm (range 7.0-12.5 mm). Final conclusion was that aUCI, or umbilical coiling pattern does not correlate with umbilical cord thickness.

Khizer Razak conducted prospective study on 100 pregnant women between 18 to 24 weeks of gestation and evaluated the relationship of sonographic measurements of umbilical cord thickness, cross sectional area and coiling index with perinatal outcome. He observed that hypocoiled cords are associated with spontaneous preterm labour and low birth weights while hypercoiled cords are associated with MSAF. The umbilical cord thickness and cross sectional area are also associated with preterm labour, low birth weight and NICU admission of the baby.

Bindu Sharma in her prospective study of 600 primigravidas with uncomplicated singleton pregnancies between 18 and 22 weeks of gestation assessed aUCI by colour Doppler. The mean aUCI was 0.41. Hypocoiling was associated with spontaneous preterm delivery (47.87 %), low Apgar score (52.13 %), LBW (52.59 %), FGR (21.28 %) and NICU admission (76.34 %). Hypercoiling was associated with preterm deliveries (65.38 %), increased caesarean sections (61.54 %), meconium staining of liquor (67.31 %), low Apgar score (63.46 %) and NICU admission (72.55 %). There was a positive strong correlation between abnormal coiling and low birth weight.

Morteza Tahmasembi studied the relationship of sonographic measurements of umbilical cord thickness, cross-sectional area and coiling index with pregnancy outcome in 255 singleton pregnant women from January 2010 to

January 2011. A statistically significant correlation was observed between small umbilical cord thickness and cross-sectional area and low birth weight (LBW), with sensitivity of 52.9% and 57.9%, specificity of 95.0% and 94.4%, positive predictive value of 52.6% and 52.0%, and negative predictive value of 95.0% and 95.0%, respectively. Also noted was significant correlation between small umbilical cord thickness and cross-sectional area with meconium staining ($P<0.001$). No significant correlation was seen between umbilical cord thickness and cross-sectional area with low 5-min Apgar score. There was no statistically significant correlation between umbilical cord coiling index and LBW, 5-min Apgar score, and meconium staining. The study concluded that umbilical cord diameter and cross-sectional area measured after 20 weeks of gestation are useful for predicting LBW and meconium staining and have the potential to serve as markers for adverse pregnancy outcome.

In a prospective analytical study conducted by T.Chitra , umbilical coiling index was calculated at the time of delivery in 1000 antenatal women. The mean umbilical coiling index was found to be 0.24 ± 0.09. Hypercoiling (>0.36) was found to be associated with diabetes mellitus, polyhydramnios, cesarean delivery, congenital anomalies, and respiratory distress of the newborn. Hypocoiling (<0.12) was found to be significantly associated with hypertensive disorders, abruptio placentae, preterm labour, oligohydramnios, and fetal heart rate abnormalities. The study concluded that abnormal umbilical coiling index is associated with several antenatal and perinatal adverse features.

Shalu Gupta in her study examined 107 cords. The mean UCI was 0.13 ± 0.08. Hypocoiled group had low Apgar score, meconium staining and poor perinatal outcome. Final conclusion of the study was that hypocoiling is associated with poor antenatal and perinatal outcome.

In a prospective cohort study done by J M Ndolo in second trimester between 18 to 24 weeks, 436 singletone pregnancies were included . This study concluded that abnormal coiling is associated with increased preterm birth.

C. Barbeiri et al in a prospective cross sectional study including 2,310 low-risk pregnancies between 12 and 40 weeks' gestation, determined the cross-sectional area of the umbilical cord, its diameter and the diameter of its vessels to establish a reference curve for these parameters during pregnancy. Means and standard deviations (SDs), plus the 10th, 50th and 90th percentiles for each measurement were calculated using polynomial regression analysis. They concluded that these parameters increased significantly with gestational age. The area of the cord also varied significantly with parity.

AIM OF THE STUDY

1. To study the correlation between abnormal antenatal umbilical cord coiling index measured sonographically between 20 to 28 weeks of gestation and adverse perinatal outcome.

2. To study the correlation between abnormal umbilical vein blood flow measured sonographically between 20 to 28 weeks of gestation and adverse perinatal outcome.

MATERIALS AND METHODS

Type of study:

Prospective Analytical study

Period of study:

September 2017 to August 2018

Study population

200 antenatal women who visited the antenatal op during the study period and who met the inclusion and exclusion criteria were included in the study.

Study setting

The study was conducted in the Department of Obstetrics and Gynecology in Tirunelveli Medical College Hospital, Tirunelveli.

Selection of cases

Inclusion criteria

- Booked case
- Singleton pregnancy
- Willing to participate and have institutional delivery at Tirunelveli Medical College and Hospital

Exclusion criteria

- All high risk pregnancies like Gestational Hypertension, Gestational Diabetes Mellitus, Anemia, Rh negative pregnancies and other complications.
- Multiple gestations
- Anomalous baby
- Single umbilical artery/placental anomaly
- Pre existing medical /surgical illness in the past and present pregnancy
- Malpresentations
- Previous caesarean section
- Inadequate visualisation of cord

Sample size: 200

Sampling technique: Convenient sampling

Study tool

Sonoscape S12 with Color Doppler (Ultrasound frequency 3.5 MHZ)

Study procedure

Antenatal UCI INDEX is calculated as reciprocal value of distance between pair of coil measured in cm from inner edge of arterial or venous wall to

outer edge of next coil along the ipsilateral side of umbilical cord, direction of coiling from the placental end to fetal end. The final value is the average of 3 readings at 3 different segments in the free floating cord.

1/distance in between adjacent pair of coils in cm

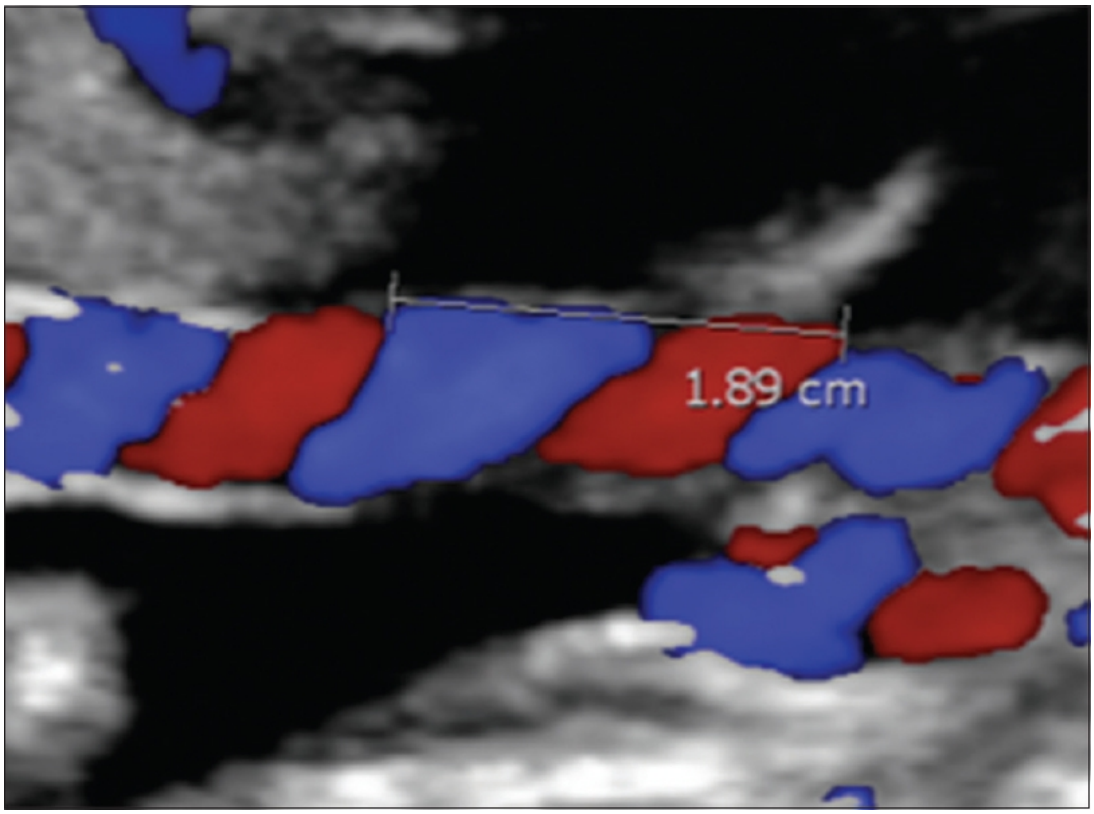


Figure 12 Color Doppler ultrasound showing measurement of the umbilical coiling index from the inner edge of an artery to the outer edge of the same artery at the adjacent umbilical twist along the ipsilateral cord side. The coiling index 0.52

Percentiles were computed for each cord parameters studied.

Cord Coiling

<10th percentile: Hypocoiled

10-90th percentile: Normocoiled

>90th percentile: Hypercoiled

.

Umbilical vein blood flow was recorded when the foetus was in a quiescent state without any body movements and during foetal apnea in the free floating portion of the umbilical cord. Pulsed colour Doppler examination was done and angle of isonisation was kept <15 degrees. The umbilical vein internal diameter was taken in the perpendicular view of longitudinal section of cord by caliper measurement.

Umbilical vein blood flow was calculated as

$$ml/min = \pi\ (UVD \times 0.5)^2 \times UV_{mean} \times 60$$

UV_{mean}: mean umbilical vein velocity in cm/s (Time averaged peak velocity measured)

UVD: Diameter of vein cm

0.5: UV spatial velocity profile coefficient

Jacqueline Spurway et al in her study has proposed normogram for umbilical vein blood flow according to gestational age.

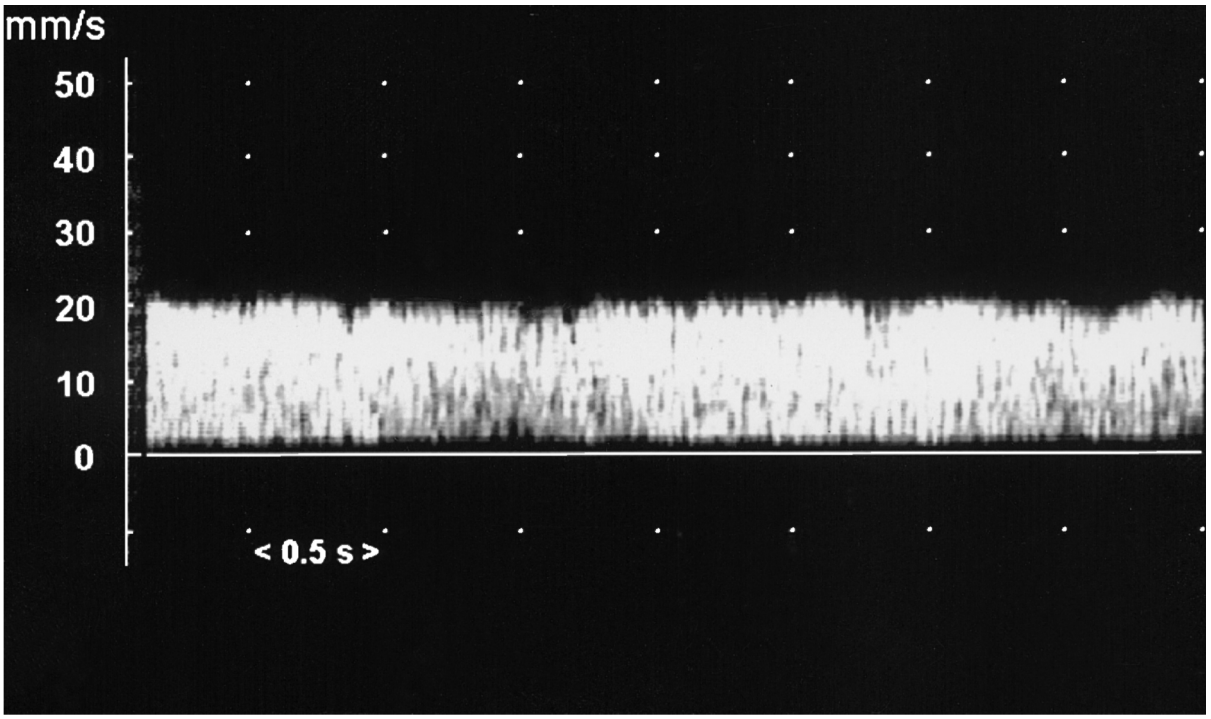


Figure 13: Umbilical vein blood flow

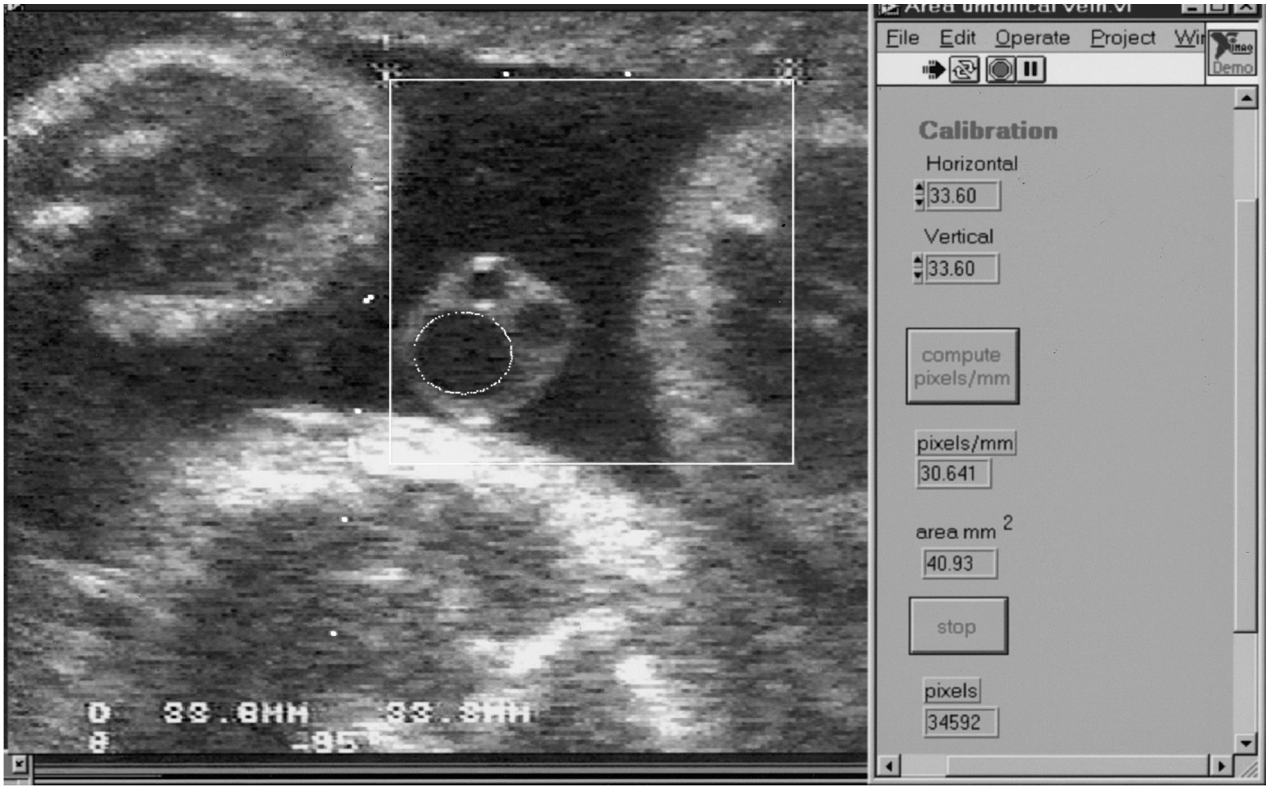


Figure 14: Measurement of umbilical vein diameter

< 10^{th} percentile: Decreased blood flow

>97^{th} percentile: Increased blood flow

10^{th} to 97^{th} percentile: Normal blood flow

These measurements were taken only once between 20 to 28 weeks. The cord parameters obtained with Doppler ultrasound are compared with adverse perinatal outcomes in terms of gestational age at delivery, intrapartum non-reassuring cardiotocography, meconium stained amniotic fluid, poor APGAR score, the neonatal birth weight, and requirement of NICU admission.

Gestational age:

Gestational age is calculated by Naegles rule by adding 9 months and 7 days to the date of last menstural period. Naegles rule can be applied only when the women are sure of their last menstural period with regular cycles for last 3 cycles and there should not be any abortion or intake of oral contraceptive pills. If there is discrepancy of 1 week between the Naegles rule and that assigned by first trimester ultrasound, then gestational age as assigned by the 1^{st} trimester ultrasound is taken into consideration.

Colour of liquor:

Colour of liquor is noted, meconium stained liquor is taken into consideration.

Intrauterine death:

The fetal deaths may be due to placental, cord, foetal and maternal complications. Fetal deaths weighing 500 grams or more occuring during pregnancy, both antepartum and intrapartum were included. The cause of IUD is unknown in 25 to 35 %.

Mode of delivery:

For the purpose of study, normal vaginal delivery and operational deliveries (forceps and vacuum) were included in the vaginal delivery. Emergency caesarean sections were included ,except those done for malpresentations and previous caesarean sections.

Fetal heart rate abnormalities:

Cardiotocographs were taken for all patients in labour and were interpreted using NICE guidelines CG190 (2017) and thus classified as normal, suspicious and pathological. Suspicious and pathological CTG were considered abnormal.

Birth weight:

All babies were weighed immediately after delivery and the birth weights less than 2.5 kg were considered as low birth weight. Weight of the babies less than 10^{th} percentile for that gestational age was considered SGA for the purpose of study. Sex of the baby was also noted.

APGAR score:

APGAR scores were noted at 1 minute and 5 minutes after delivery. An APGAR of less than 7 at 1 min and 5 min was considered abnormal.

	Colour	Heart Rate	Respiration	Reflex Response	Muscle Tone
0	Pale or blue	Absent	Absent	Absent	Absent
1	Body pink, extremities blue	<100	Irregular	Grimace or noticeable facial movements	Some flexion of extremities
2	Body and extremities pink	>100	Good breathing and crying	Coughs, sneezes or pulls away	Active and spontaneous movement of limbs

NICU Admission

Babies admitted to NICU for various conditions like preterm, respiratory distress syndrome and low birth weight were included in study.

Data management and analysis

Data was coded in the MS-EXCEL and analysed using SPSS software. Qualitative data was expressed in percentage and analysed using chi square

chart. Quantitative data was expressed in mean and standard deviation and analysed using independent t test.

The continous variables of the study subjects were described in terms of averages and the category variables were described in terms of percentages.

The relationships between the continous variables were studied by Karl Pearson correlation coefficient r and the ordinal variables by Spearman rank correlation r_s. The associations between the categorical variables were analyzed and interpreted by χ^2 (Chi-square) test. The statistical procedures were performed with the help of the statistical package namely IBM SPSS statistics - 20. The P values less than or equal to 0.05 ($P \leq 0.05$) were considered as statistically significant. A p value of less than 0.05 was considered significant.

RESULTS AND ANALYSIS

Description of mothers according to their age and obstetric score:

The mothers' maternal age and obstetric score like gravida was described.

Table-1: Maternal age distribution of mothers:

Age group (years)	No of mothers	%	Mean age	SD
15-19	17	8.5	24.8 (Range 17-37 years)	4.1
20-24	86	43.0		
25-29	69	34.5		
30-34	26	13.0		
35-39	2	1.0		
Total	200	100.0		

The table -1 describes the mothers according to their age, with maximum of 43% in the age group of 20-24 years. The mean age of mothers was 24.8±4.1 years with minimum age as 17 and maximum as 37 years.

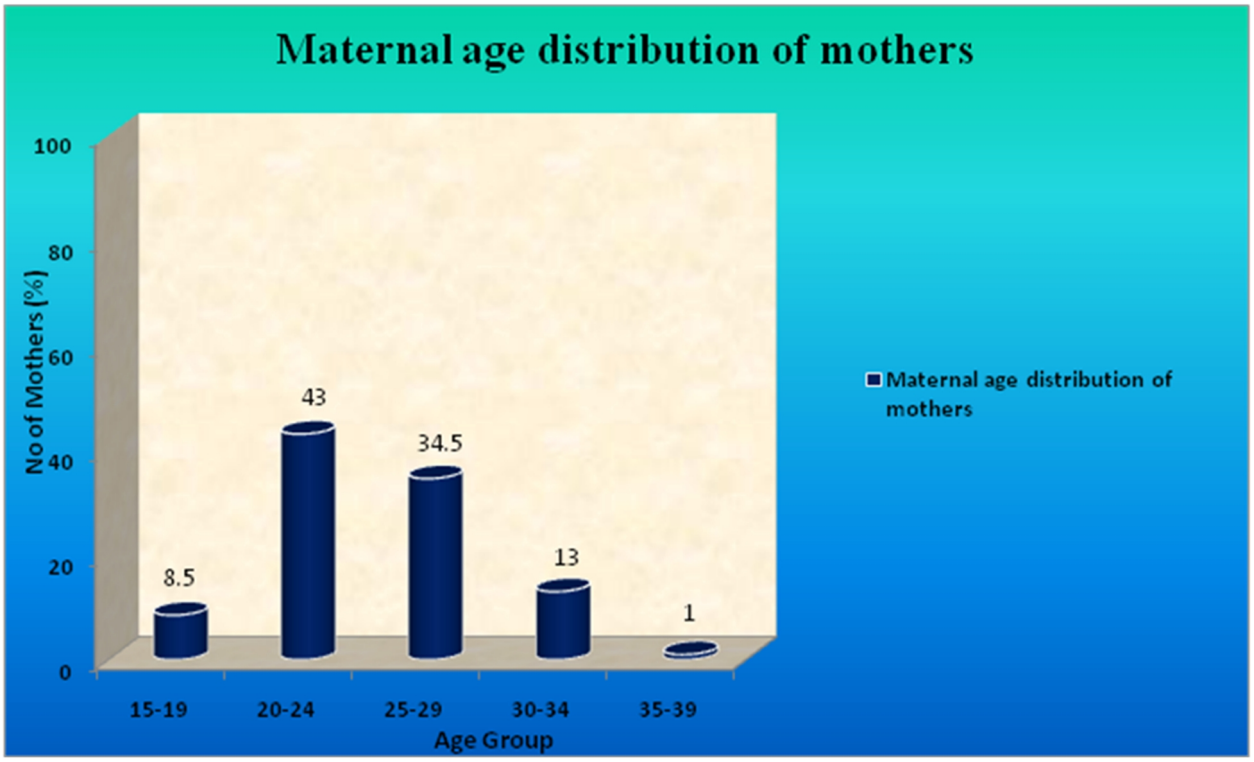

Maternal age distribution of mothers
100
80
60
40
20
0
No of Mothers (%)
43
34.5
13
8.5
1
15-19
20-24
25-29
30-34
35-39
Age Group
Maternal age distribution of mothers

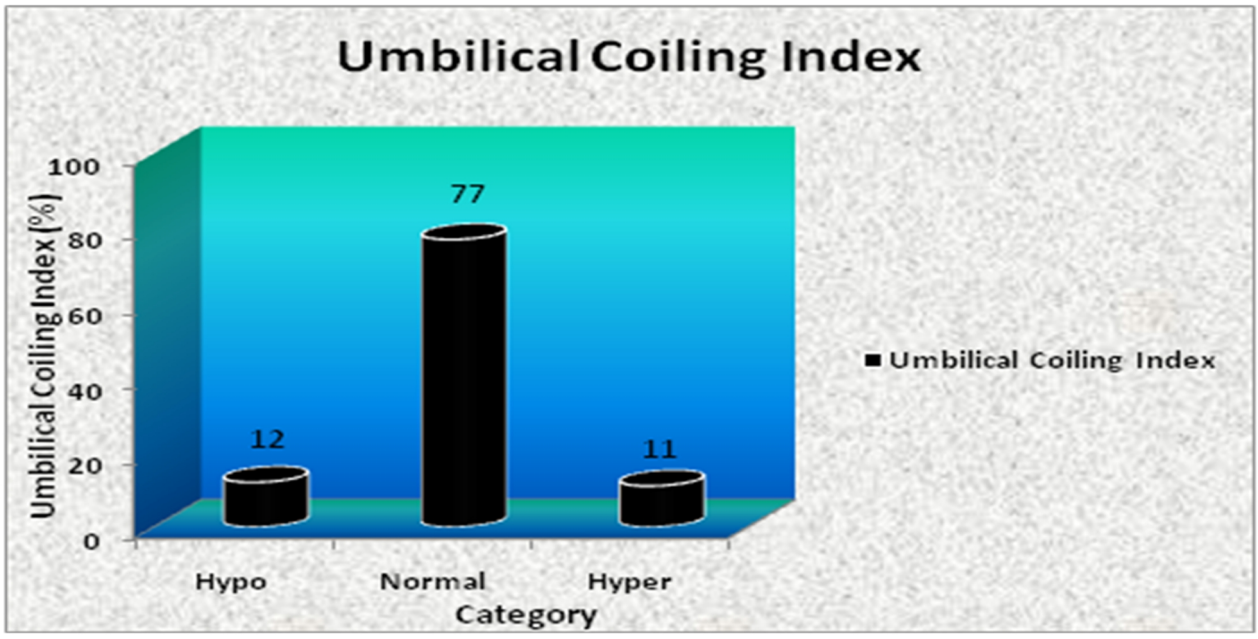
Table-2: Distribution of mothers according to their obstetrics score:

Sl No	Obstetrics score	Category	Frequency	%
1	Gravida	Primi	113	56.5
		G2	57	28.5
		G3	25	12.5
		G4	5	2.5

The above table-2 states the obstetrics score of the study subjects. In respect of gravida, the maximum was primi as 56.5% and the multi gravida was 43.5%.

Table-3(a): Description of Umbilical coiling index.

Variable	Category	Frequency	%
Umbilical coiling index	Hypo	24	12
	Normal	154	77
	Hyper	22	11
	Total	200	100



The table-3(a) describes the normality of UCI . Among the UCI normal, hypo and hyper were 77%, 12% and 11% respectively.

Table-3(b): Description of Doppler flow.

Variable	Category	Frequency	Percentage
Umbilical vein Doppler flow	Decreasing	21	10.5
	Normal	172	86
	Increasing	7	3.5
	Total	200	100

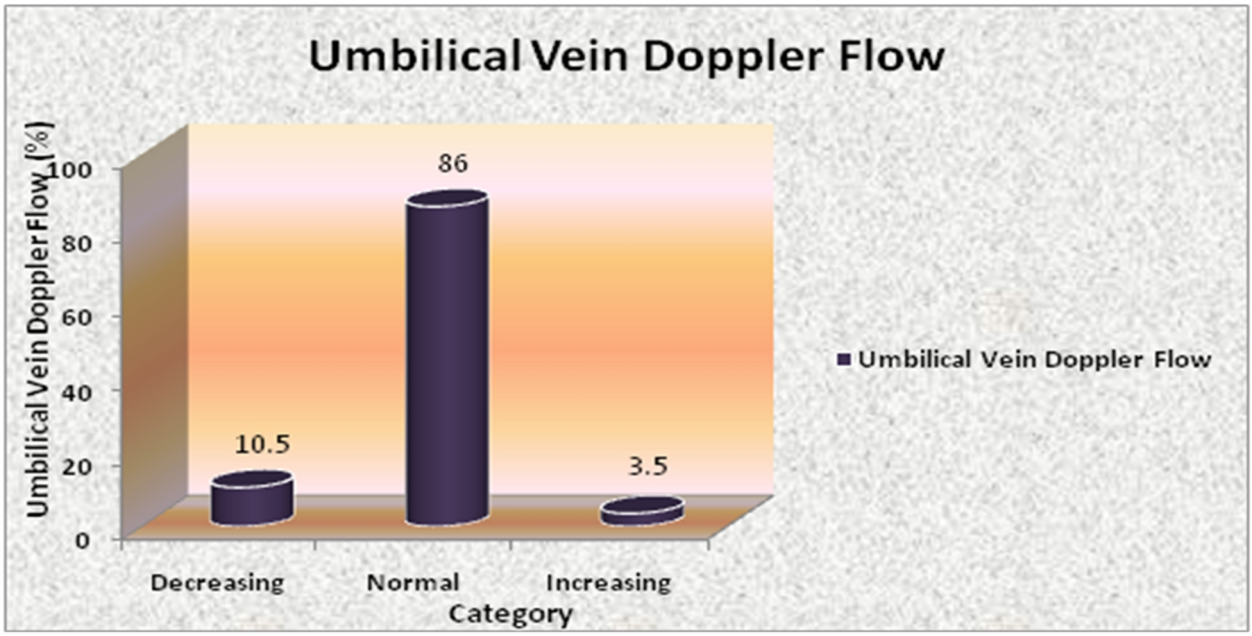


Table 3 (b):In respect of UmV, the normal, decreasing and increasing were 86%, 10.5% and 3.5% respectively.

Table-4: Description of outcome according to their obstetrics characteristics:

Sl. No	OB Characteristics	Category	Frequency	%
1	Term	Pre Term	19	9.5
		Term	181	90.5
2	Mode of delivery	NVD	138	69.0
		LSCS	62	31.0
3	CTG	Not applicable	8	4.0
		Abnormal	41	20.5
		Normal	151	75.5
4	MSL	Yes	33	16.5
		No	167	83.5
5	IUD	Yes	2	1.0
		No	198	99.0
6	Gender of Baby	Male	109	54.5
		Female	91	45.5
7	Birth weight of baby	Normal	162	81.0
		LBW	21	10.5
		SGA	17	8.5
8	APGAR at 1 Min	<7	37	18.5
		>7	163	81.5
9	APGAR at 5 Min	<7	6	3.0
		>7	194	97.0
10	NICU admission	Yes	43	21.5
		No	157	78.5

The table-4 describes the outcome characteristics of the study subjects.

The term and pre term babies were 90.5% and 9.5%.

The normal deliveries were 69% and LSCS were 31%.

The CTG not applicable, abnormal and normal were 4%, 20.5% and 75.5% respectively.

The MSL present was 16.5% and absent were 83.5%.

The IUD was 1% only.

In respect of the gender, the males were 54.5% and females were 45.5%.

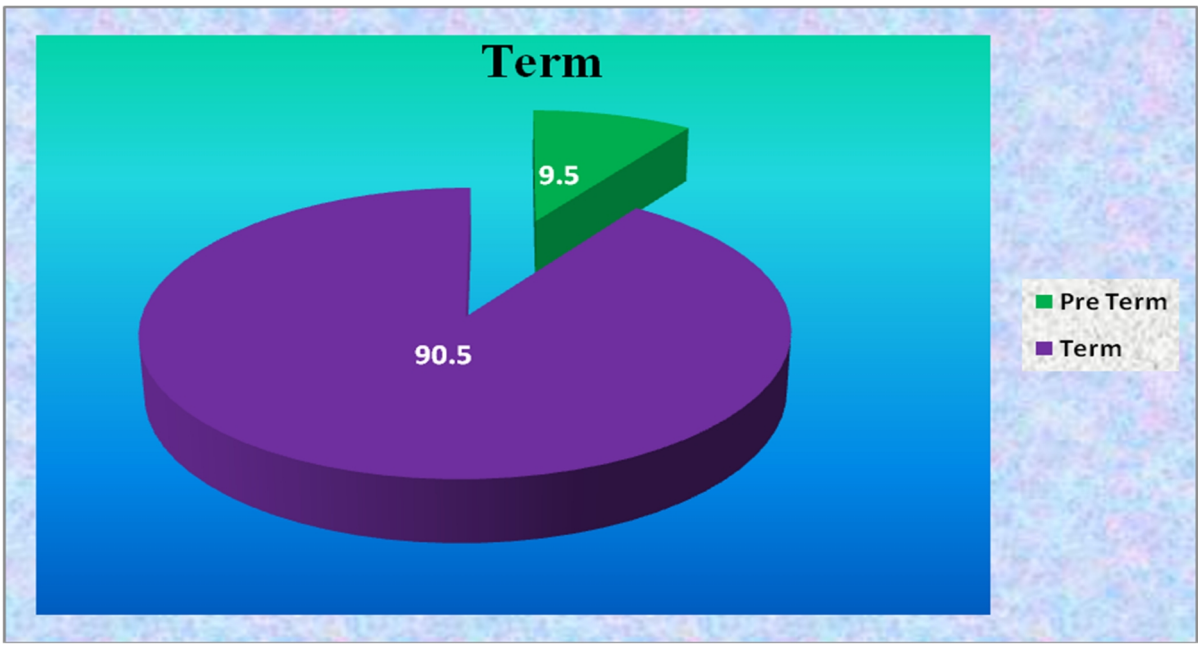
The normal birth weight babies were 81% and low birth weight babies were 10.5%. The small for gestational age babies were 8.5%.

The APGAR scores at minute less than 7 babies were 18.5% and >7 were 81.5%.

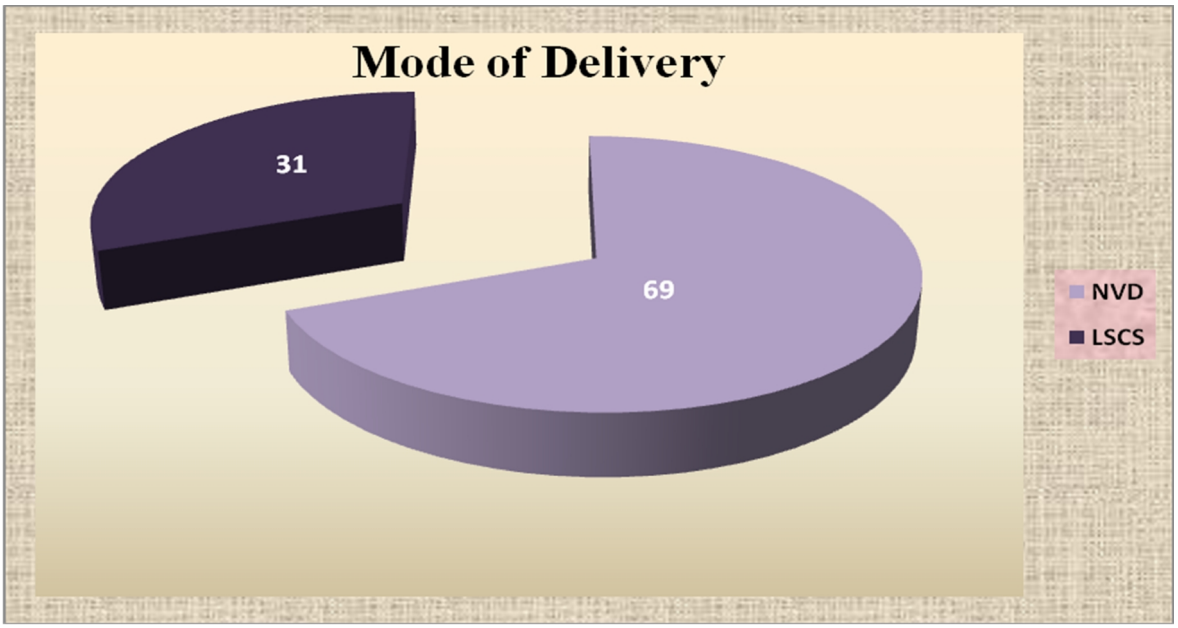
At 5 minutes the APGAR score <7 babies were 3% and >7 were 97%.

The babies were admitted in NICU was 21.5%.

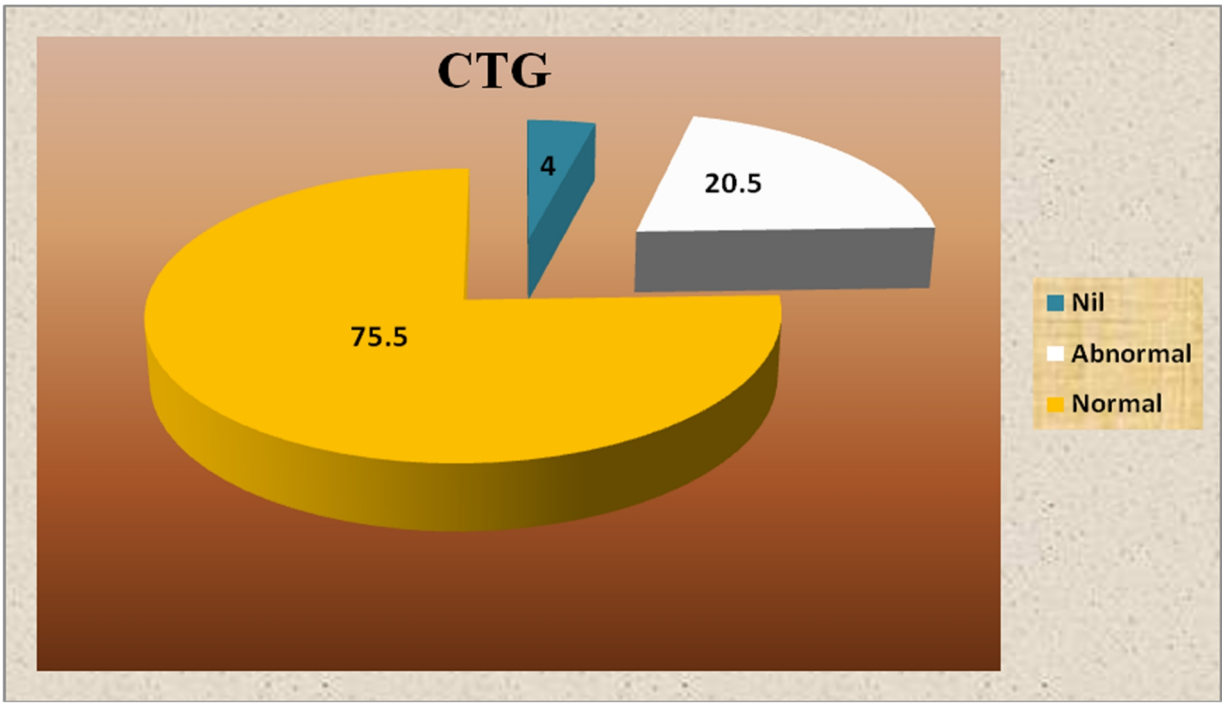
The term and pre term babies were 90.5% and 9.5%.



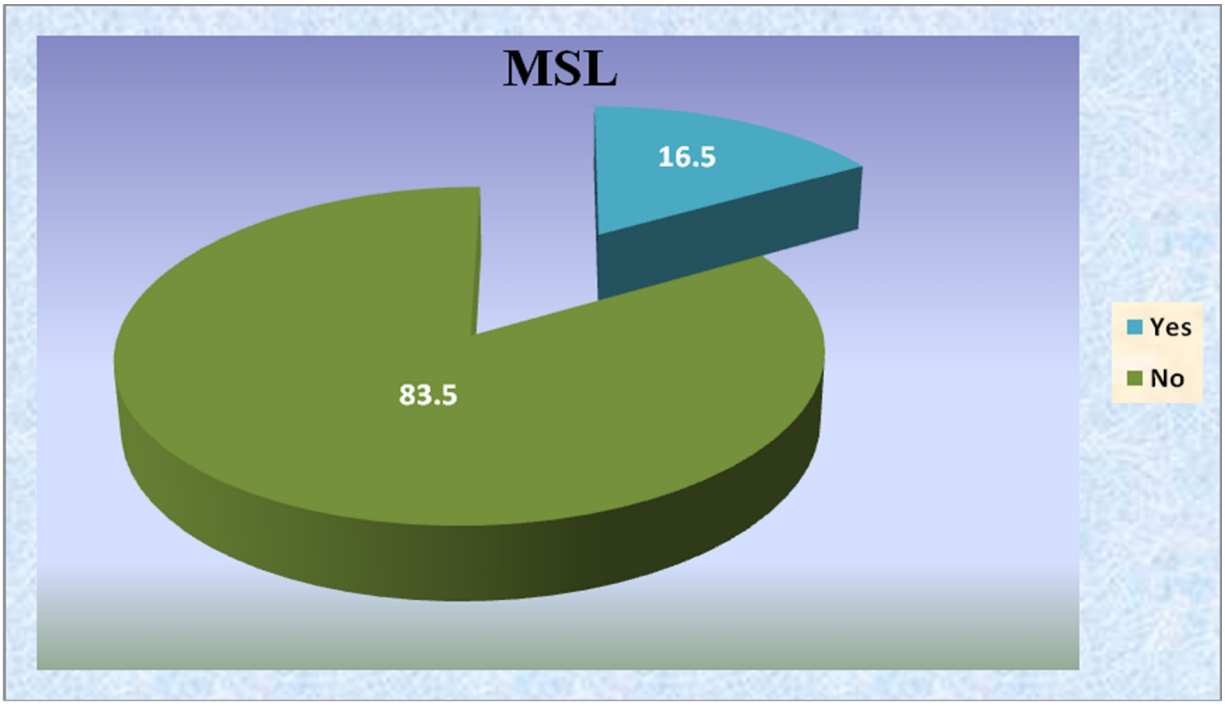
The normal deliveries were 69% and LSCS were 31%.



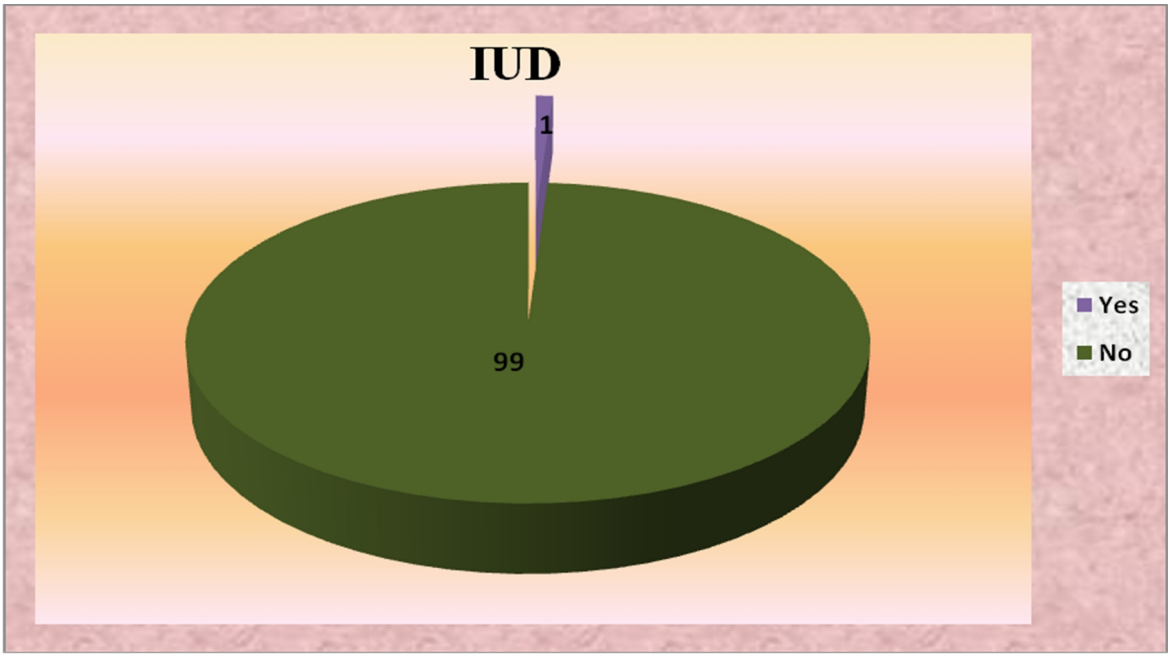
The CTG not applicable, abnormal and normal were 4%, 20.5% and 75.5% respectively.



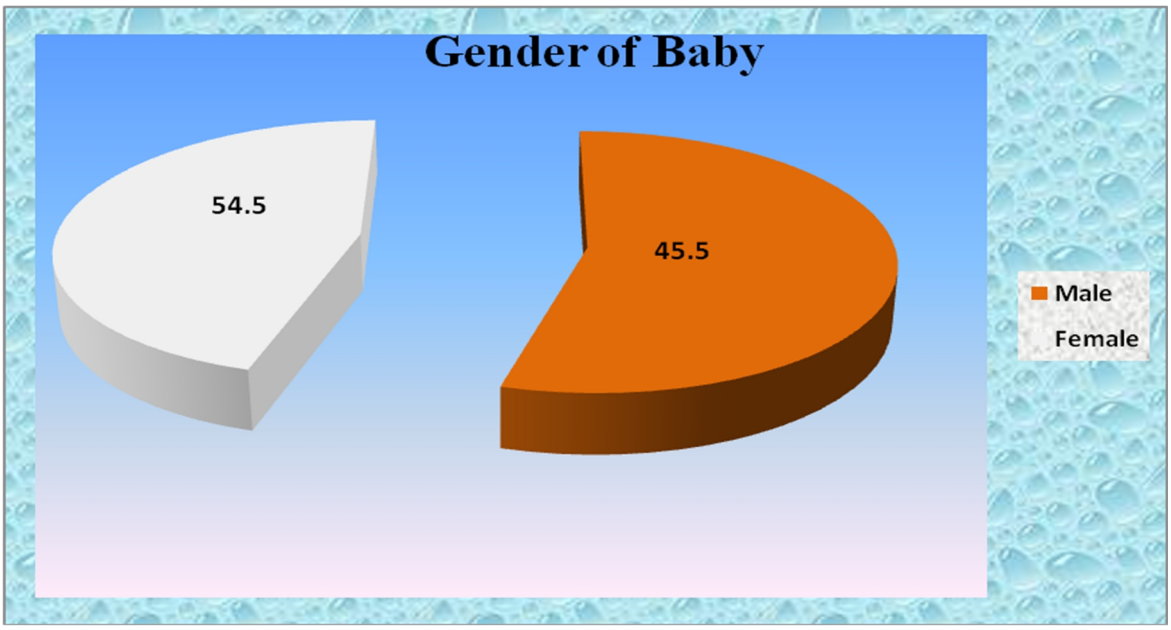
The MSL present was 16.5% and absent were 83.5%.



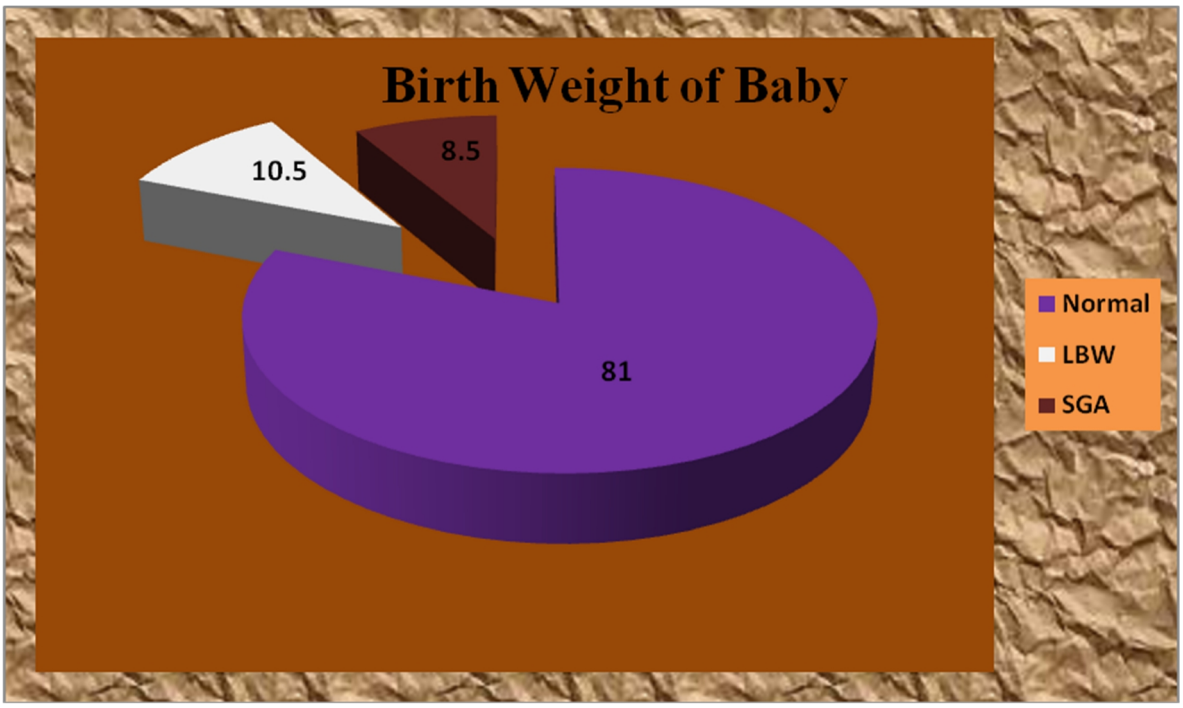
Live birth 99% ,IUD 1%



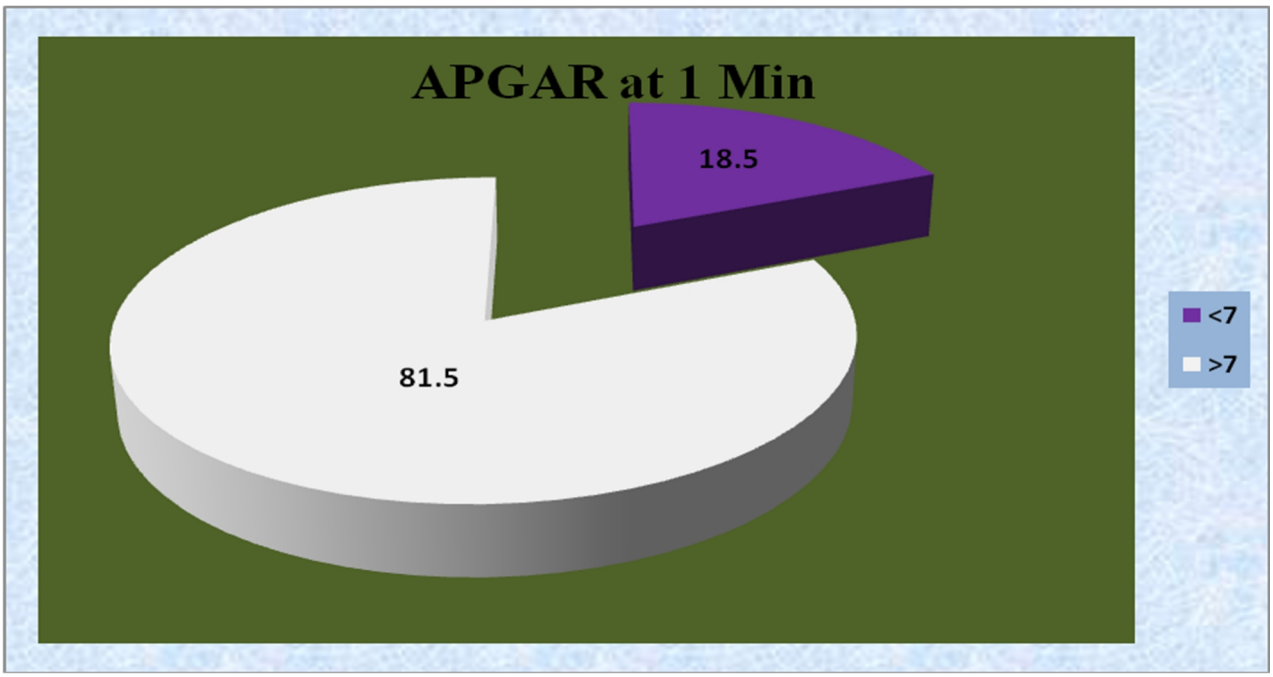
Males were 54.5% and Females were 45.5%



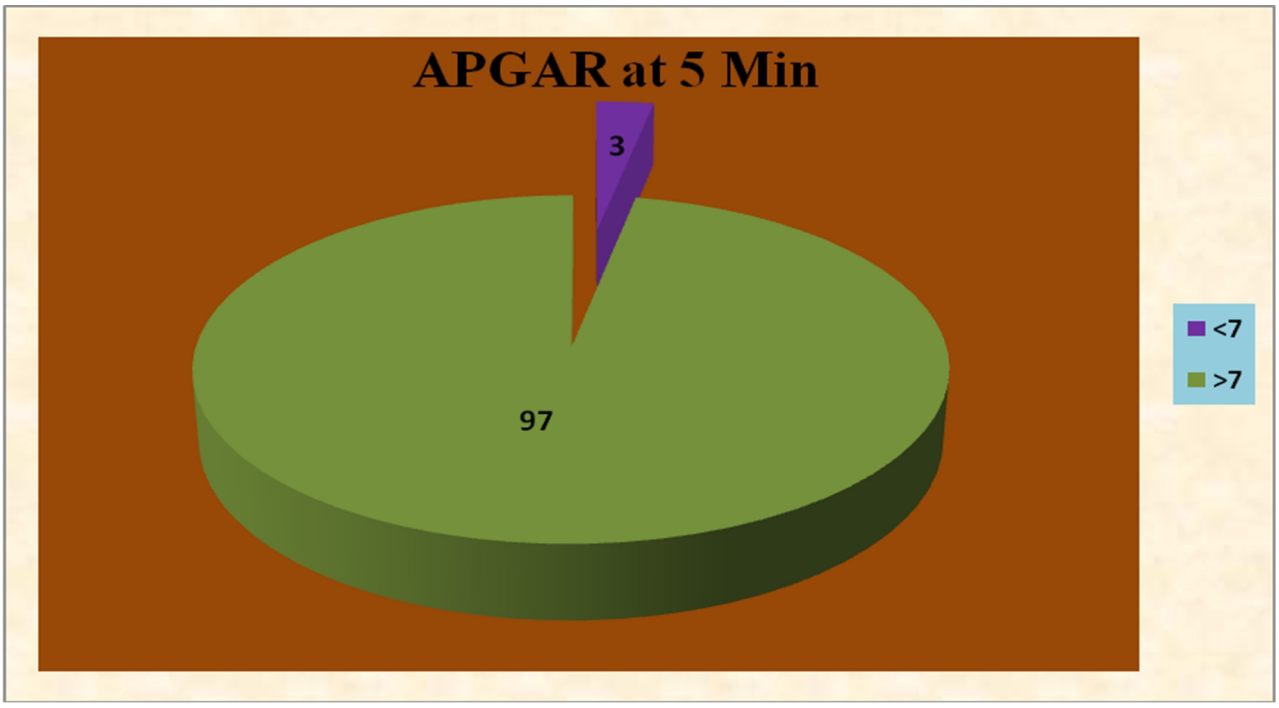
The normal birth weight babies were 81% and low birth weight babies were 10.5%. The small for gestational age babies were 8.5%.



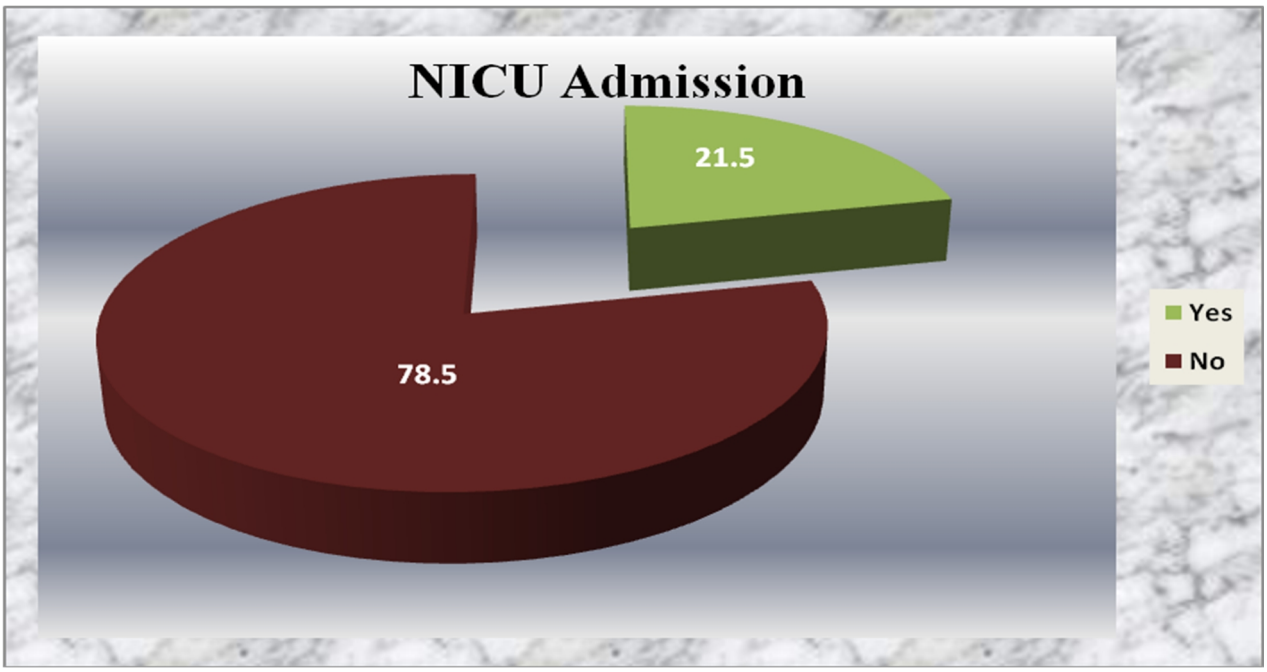
The APGAR scores at 1 minute less than 7 babies were 18.5% and >7 were 81.5%



At 5 minutes the APGAR score <7 babies were 3% and >7 were 97%.



The babies were admitted in NICU was 21.5%.



Relationship between mothers' age with AN Umbilical coiling and Doppler flow:

The relationships between mothers' ages with UCI and Doppler flow were correlated.

Table-5 (a): Correlation between mothers' maternal ages with UCI and UmV:

Variables	n	r	Sig	r^2	% of r^2	Determination
Mothers' age x UCI	200	0.047	P=0.508	0.0022	0.22	Not determined
Mothers' age x UMV	200	0.020	P=0.774	0.0004	0.04	Not determined

The table-5 (a) correlates the mothers' age with UCI and UmV. There was no statistically significant relationship between mothers' age with UCI and UmV.

Relationship between AN Umbilical coiling and Doppler flow:

The relationships between UCI and Doppler flow were correlated.

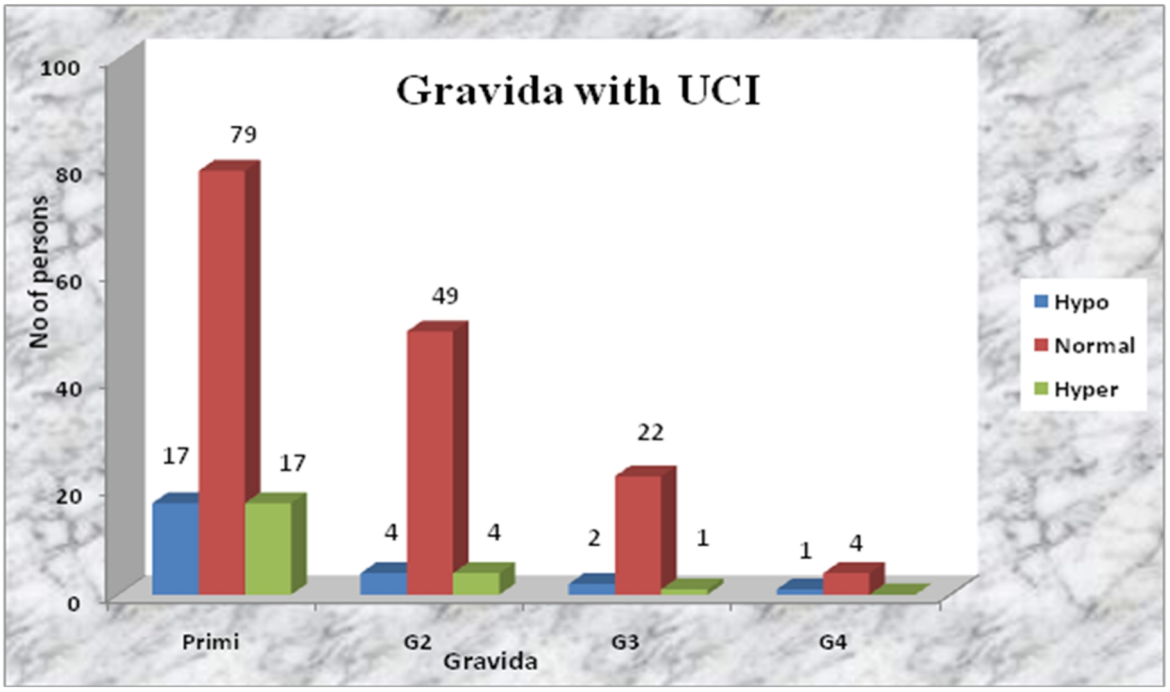
Table 5(b) : Correlation between UCI and UmV:

Variables	**n**	**r**	**Sig**	**r^2**	**% of r^2**	**Determination**
UCI X UmV	200	0.221	P=0.002	0.049	4.9	Determined 4.9%

Table 5(b) : Correlates UCI and UmV. There was statistically significant relationship between UCI and UmV. The UCI determined 4.9% of UmV.

Table-6: Association between Gravida with UCI:

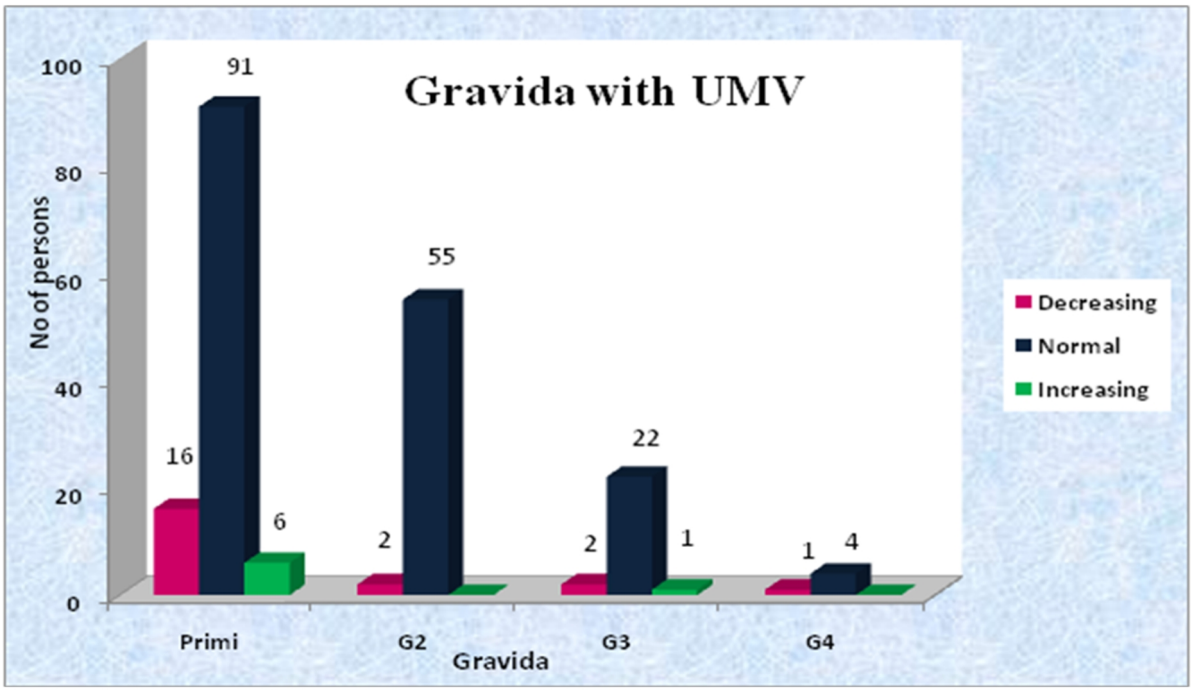
Gravida	**Hypo**	**Normal**	**Hyper**	**Total**	**χ^2**	**df**	**Sig**
Primi	17	79	17	113	8.549	6	P=0.201
G2	4	49	4	57			
G3	2	22	1	25			
G4	1	4	0	5			
Total	24	154	22	200			



The above table -6 states the relationship between gravida with UCI. The gravida did not determine the UCI, hence there is no association between obstetric score and UCI (P>0.05).

Table-7: Association between Gravida with UmV:

Gravida	Decreasing	Normal	Increasing	Total	χ^2	df	Sig
Primi	16	91	6	113	9.073	6	P=0.169
G2	2	55	0	57			
G3	2	22	1	25			
G4	1	4	0	5			
Total	21	172	7	200			



The above table -7 states the relationship between gravida with UmV. The gravida did not determine the UmV, hence there is no aasociation between gravid and UmV (P>0.05).

Relationship between UCI and UmV with Outcome:

Table-8: Correlation between UCI and UmV with gestational age (GA):

Variables	n	r	Sig	r^2	r^2 (%)	Determination
UCI x GA	200	0.301	P<0.001	0.091	9.1	Determined 9.1% of GA
UmV x GA	200	0.239	P=0.001	0.057	5.7	Determined 5.7% of GA

The table-8 correlates the UCI and UmV with gestational age. The results revealed that there was positive correlation between UCI and UmV and the gestational age (P<0.001). The UCI determined the GA 9.1% and the UMV determined 5.7%.

Table-9: Correlation between UCI and UmV with birth weight of baby (BWB)

Variables	n	r	Sig	r^2	r^2 (%)	Determination
UCI x BWB	200	0.293	P<0.001	0.086	8.6	Determined 8.6% of BWB
UmV x BWB	200	0.222	P=0.002	0.049	4.9	Determined 4.9% of BWB

The table-9 correlates the UCI and UmV with BWB. The results revealed that there were positive correlation between UCI and UmV and the BWB (P<0.001). The UCI determined the BWB 8.6% and the UmV determined 4.9%.

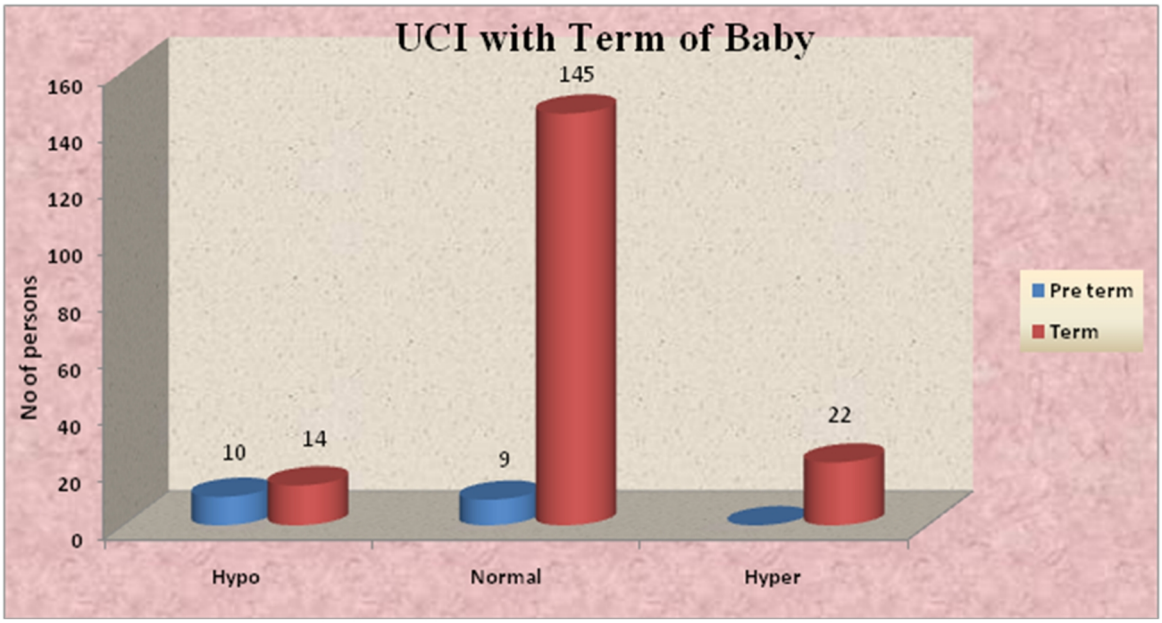
Table-10: Correlation between UCI and UmV with APGAR 1 and 5 Minutes.

Variables	n	r_s	Sig	r_s^2	r_s^2 (%)	APGAR Determination
UCI x APGAR-1min	200	0.142	P=0.044	0.020	2.0	Determined 2.0% of A
UmV xAPGAR-1min	200	0.367	P<0.001	0.135	13.5	Determined 13.5% of A
UCI x APGAR-5min	200	0.142	P=0.045	0.020	2.0	Determined 2.0% of A
UmV xAPGAR-5min	200	0.273	P<0.001	0.075	7.5	Determined 7.5% of A

The table-10 correlates the UCI and UmV with APGAR at 1 and 5 Minutes. The results revealed that there was positive correlation between UCI and the APGAR-1and 5 minutes (P<0.05). The UCI determined the APGAR1 and 5 minutes 2.0% each. The statistically significant correlation between UmV and the APGAR-1 and 5 minutes (P<0.001). The UmV determined APGAR-1 and 5 minutes as 13.5% and 7.8% respectively.

Table-11: Association between UCI with term of baby:

UCI	Pre term	Term	Total	χ^2	df	Sig
Hypo	10	14	24	33.587	2	P<0.001
Normal	9	145	154			
Hyper	0	22	22			
Total	19	181	200			

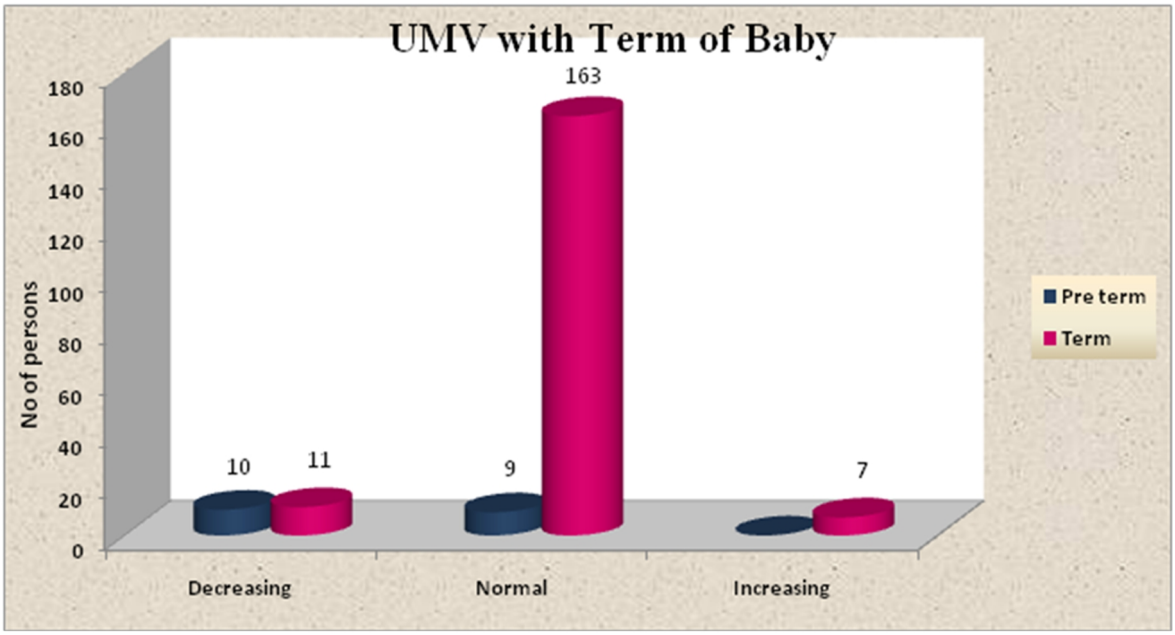


The above table -11 states the association between UCI with term of baby.

The UCI hypo was associated with pre term baby and normal was associated with term baby. The associations were statistically very highly significant (P<0.00).

Table-12: Association between UmV with term of baby:

UmV	Pre term	Term	Total	χ^2	df	Sig
Decreasing	10	11	21	39.870	2	P<0.001
Normal	9	163	172			
Increasing	0	7	7			
Total	19	181	200			

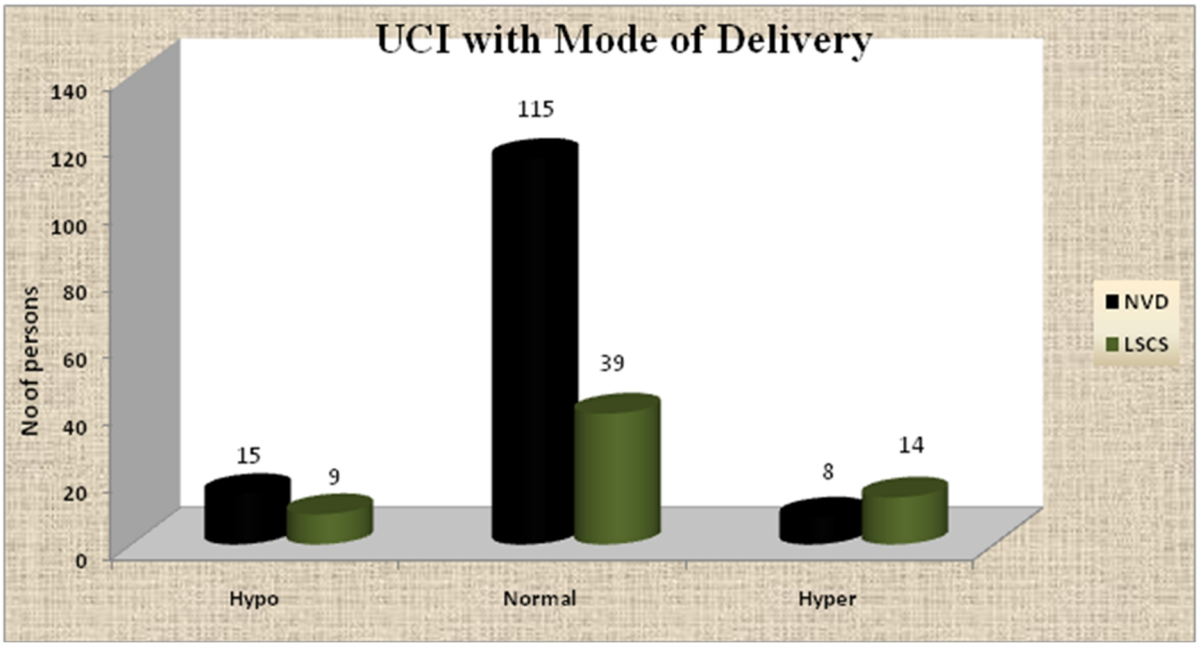


The above table -12 states the association between UmV with term of baby.

The UmV decreasing was associated with pre term baby and normal was associated with term baby. The associations were statistically very highly significant (P<0.00).

Table-13: Association between UCI with mode of delivery:

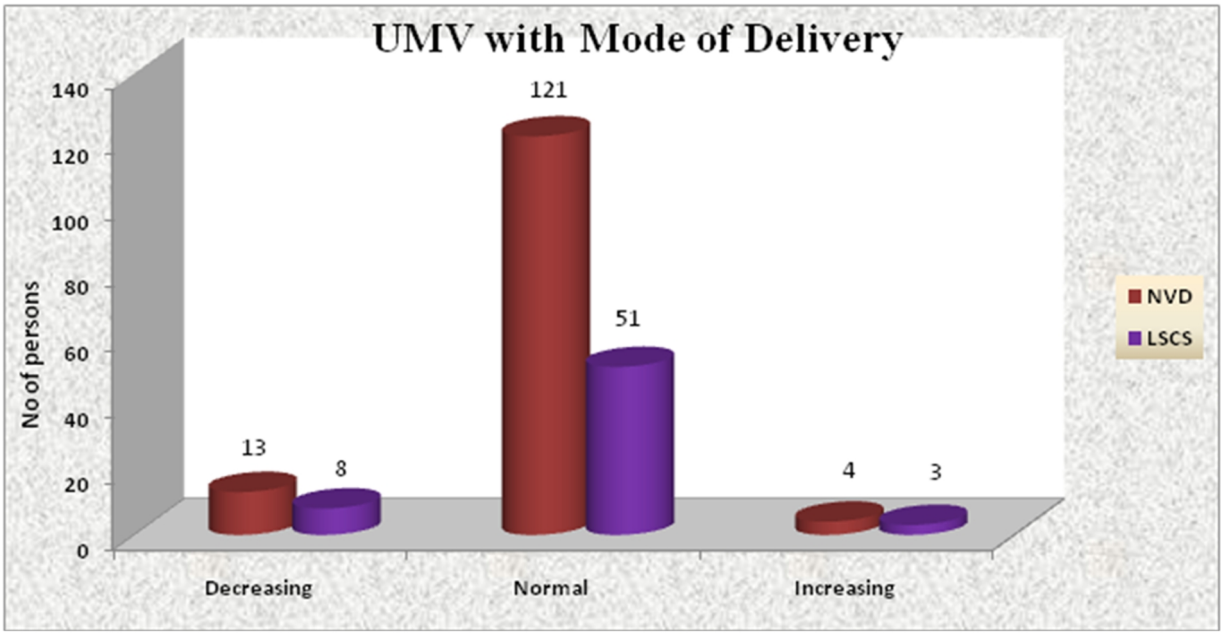
UCI	NVD	LSCS	Total	χ^2	df	Sig
Hypo	15	9	24	33.587	2	P<0.001
Normal	115	39	154			
Hyper	8	14	22			
Total	138	62	200			



The above table -13 states the association between UCI with mode of delivery. The UCI normal was associated with NVD and hyper was associated with LSCS. The association was statistically very highly significant (P<0.00).

Table-14: Association between UmV with mode of delivery:

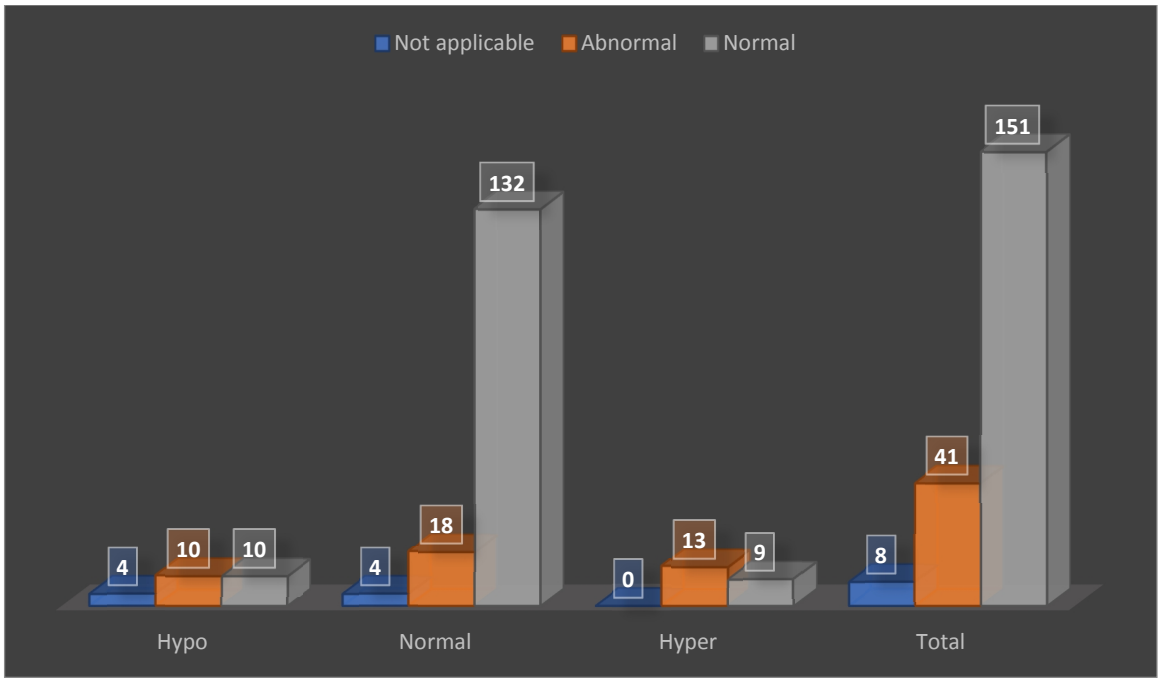
UmV	NVD	LSCS	Total	χ^2	df	Sig
Decreasing	13	8	21	1.101	2	P=0.577
Normal	121	51	172			
Increasing	4	3	7			
Total	138	62	200			



The above table -14 states the association between UmV with mode of delivery. The UmV had no statistically significant association with mode of delivery (P>0.05).

Table-15: Association between UCI with CTG:

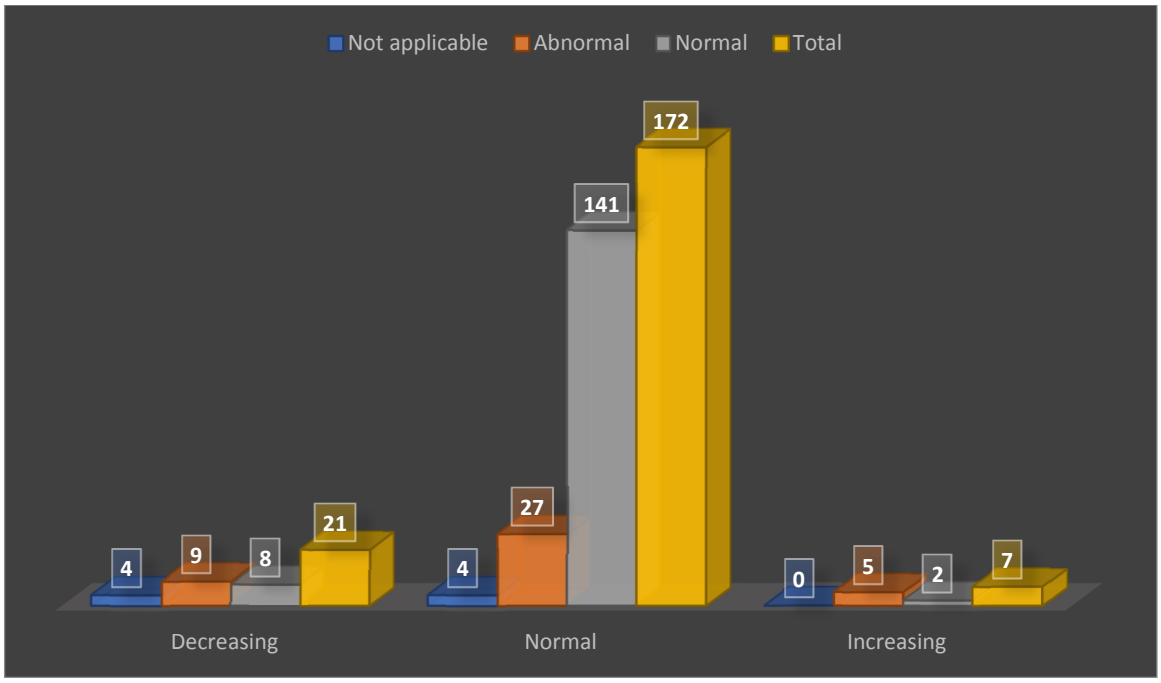
UCI	Not applicable	Abnormal	Normal	Total	χ^2	df	Sig
Hypo	4	10	10	24	48.634	4	P<0.001
Normal	4	18	132	154			
Hyper	0	13	9	22			
Total	8	41	151	200			



The above table -15 states the association between UCI with CTG. The UCI of normal was strongly associated with normal CTG (P<0.001). The UCI hyper was associated with abnormal CTG (P<0.001)

Table-16: Association between UmV with CTG:

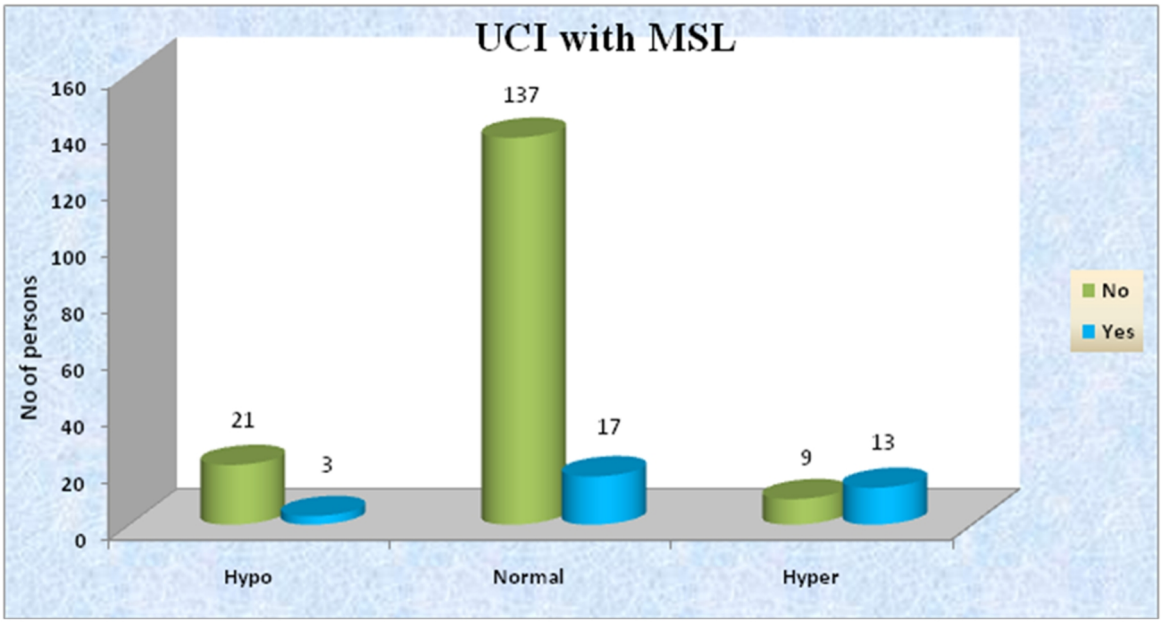
UmV	Not applicable	Abnormal	Normal	Total	χ^2	df	Sig
Decreasing	4	9	8	21	31.917	4	P<0.001
Normal	4	27	141	172			
Increasing	0	5	2	7			
Total	8	41	151	200			



The above table -16 states the association between UmV with CTG. The UmV of normal was strongly associated with normal CTG and increases UmV was associated with abnormal CTG (P<0.001).

Table-17: Association between UCI with MSL:

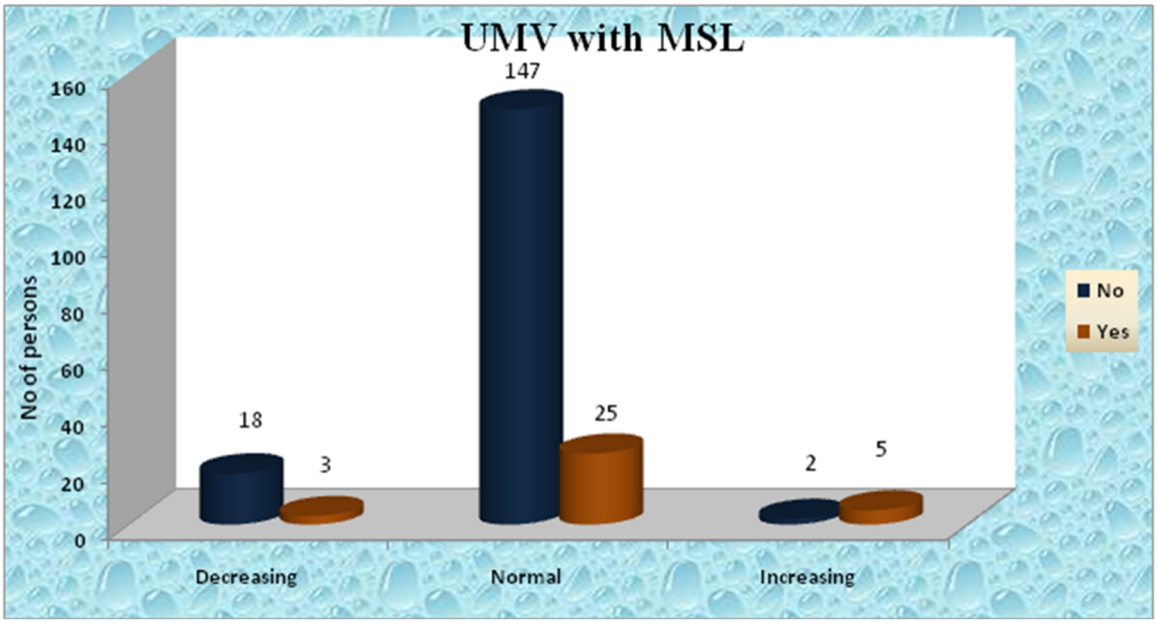
UCI	No	Yes	Total	χ^2	df	Sig
Hypo	21	3	24	32.578	2	P<0.001
Normal	137	17	154			
Hyper	9	13	22			
Total	167	33	200			



The above table -17 states the association between UCI with MSL. The UCI of normal was strongly associated with MSL negative and hyper was associated with MSL (P<0.001).

Table-18: Association between UmV with MSL:

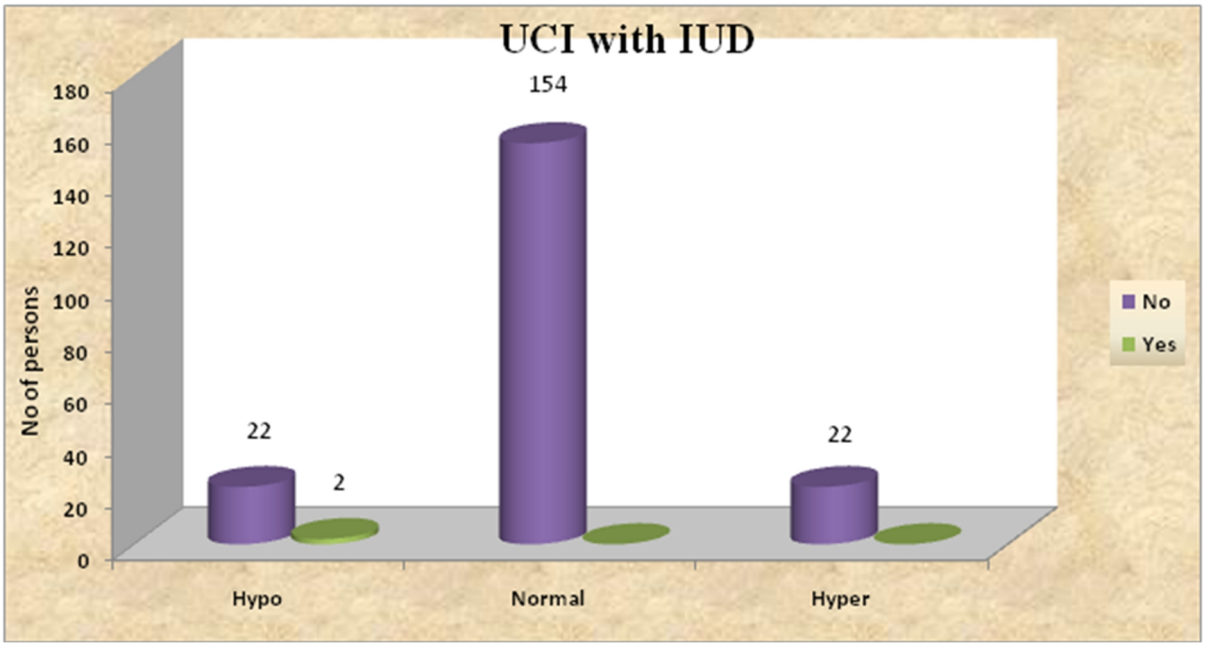
UmV	No	Yes	Total	χ^2	df	Sig
Decreasing	18	3	21	15.886	2	P<0.001
Normal	147	25	172			
Increasing	2	5	7			
Total	167	33	200			



The above table -18 states the association between UmV with MSL. The UMV of normal was strongly associated with MSL negative and increased UmV was associated with MSL (P<0.001).

Table-19: Association between UCI with IUD:

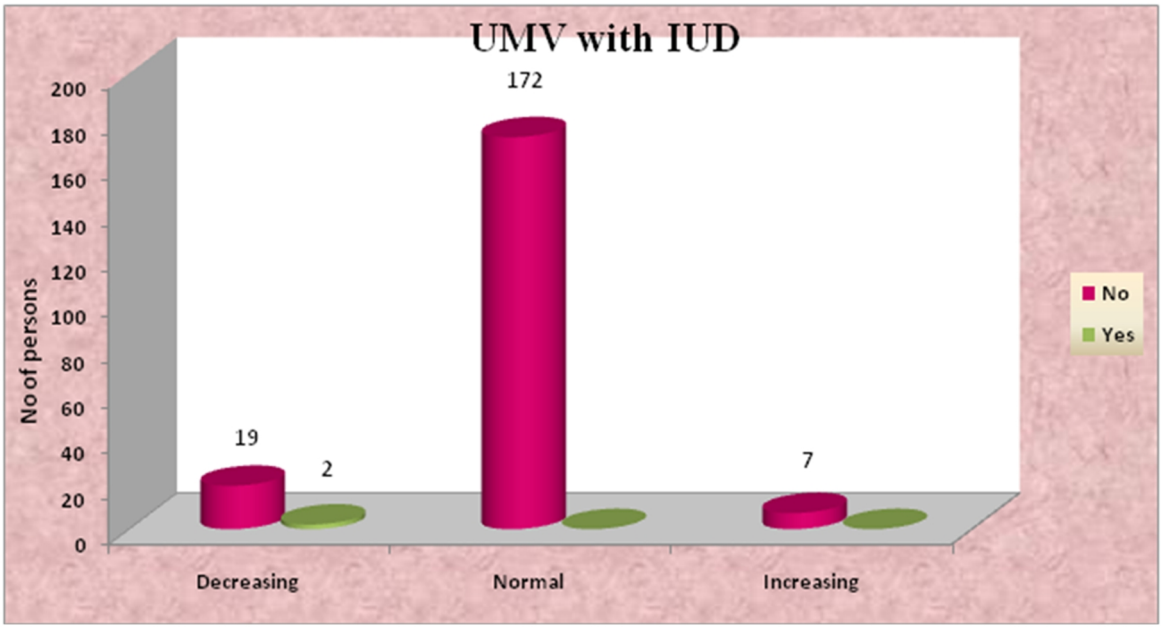
UCI	No	Yes	Total	χ^2	df	Sig
Hypo	22	2	24	14.815	2	P<0.001
Normal	154	0	154			
Hyper	22	0	22			
Total	198	2	200			



The above table -19 states the association between UCI with IUD. The UCI of hypo was strongly associated with IUD (P<0.001).

Table-20: Association between UmV with IUD:

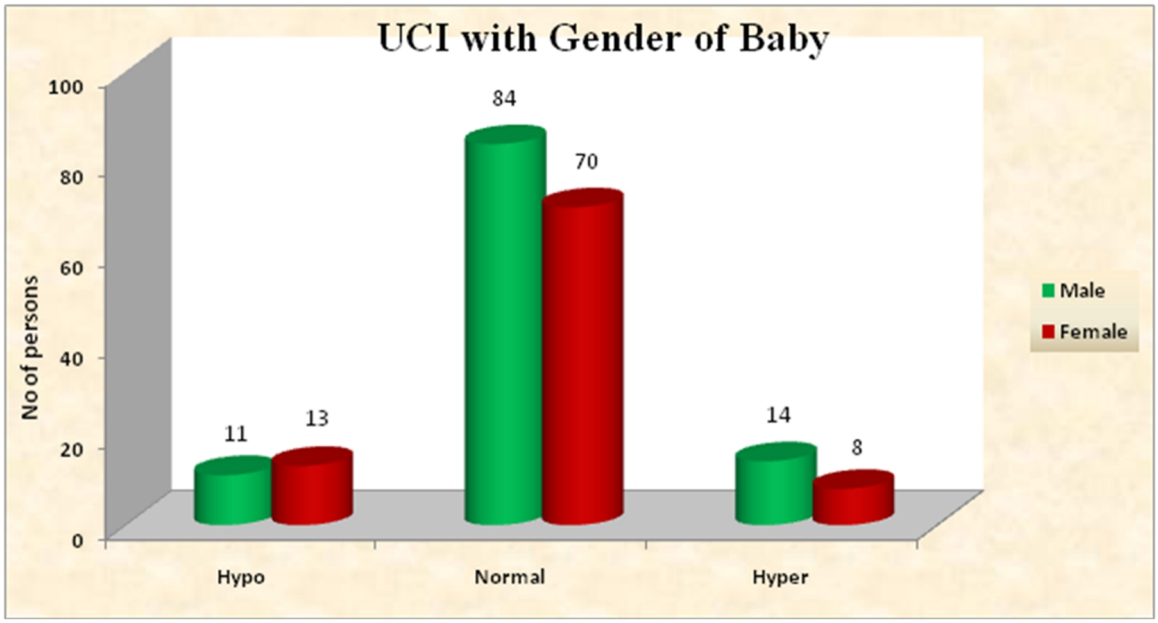
UMV	No	Yes	Total	χ^2	df	Sig
Decreasing	19	2	21	17.220	2	P<0.001
Normal	172	0	172			
Increasing	7	0	7			
Total	198	2	200			



The above table -20 states the association between UmV with IUD. The UmV of decreasing was strongly associated with IUD (P<0.001).

Table-21: Association between UCI with gender of baby:

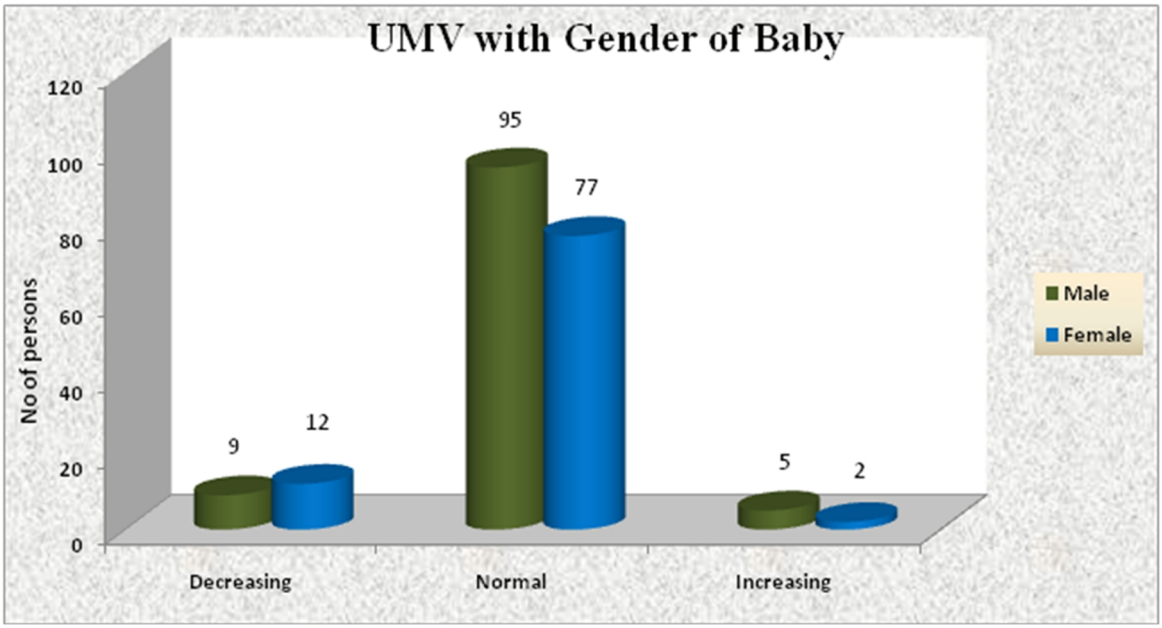
UCI	Male	Female	Total	χ^2	df	Sig
Hypo	11	13	24	1.468	2	P=0.480
Normal	84	70	154			
Hyper	14	8	22			
Total	109	91	200			



The above table -21 states the association between UCI with gender of baby. The UCI did not associate with gender of baby (P>0.05).

Table-22: Association between UmV with gender of baby:

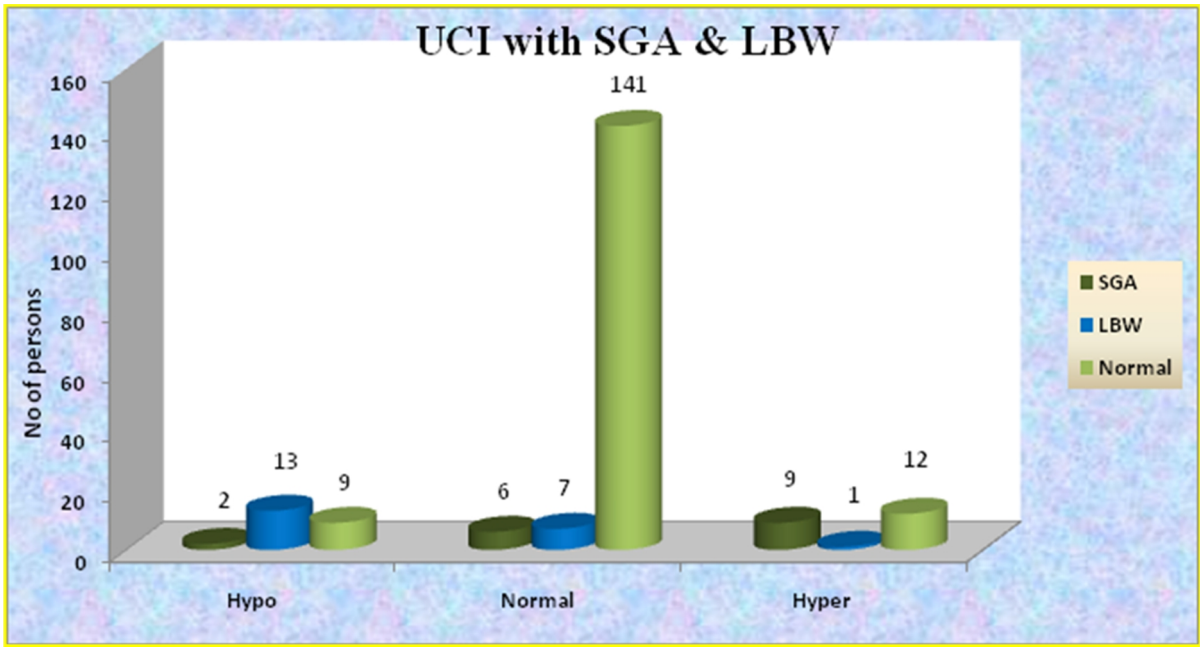
UmV	Male	Female	Total	χ^2	df	Sig
Decreasing	9	12	21	1.994	2	P=0.369
Normal	95	77	172			
Increasing	5	2	7			
Total	109	91	200			



The above table -22 states the association between UmV with gender of baby. The UmV did not associate with gender of baby (P>0.05).

Table-23: Association between UCI with SGA & LBW:

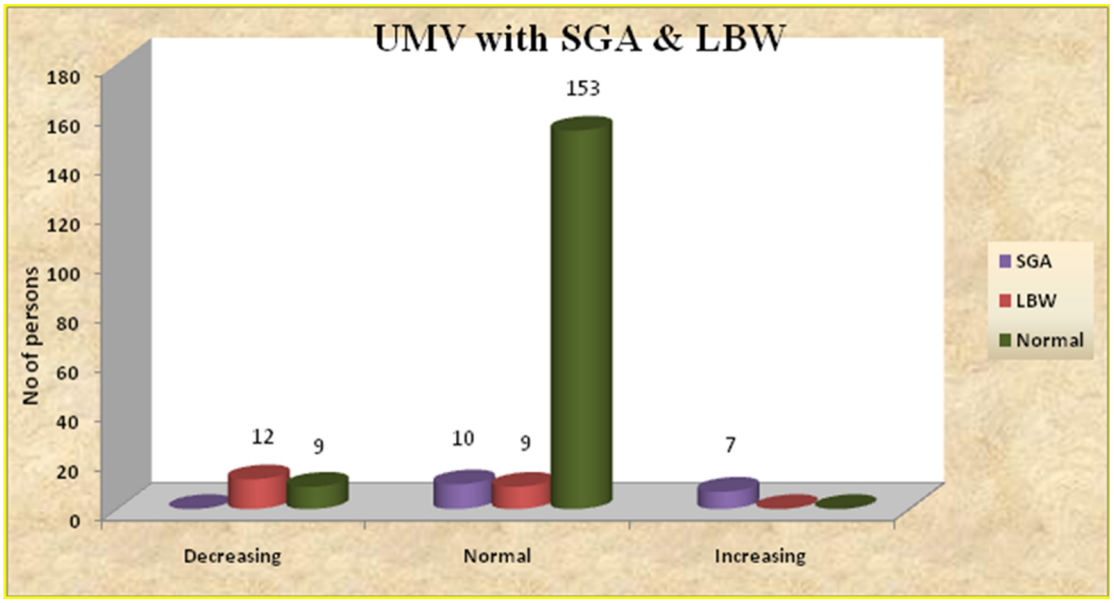
UCI	SGA	LBW	Normal	Total	χ^2	df	Sig
Hypo	2	13	9	24	72.222	4	P<0.001
Normal	6	7	141	154			
Hyper	9	1	12	22			
Total	17	21	162	200			



The above table -23 states the association between UCI with SGA & LBW. The UCI of hypo was strongly associated with LBW. The hyper was strongly associated with SGA (P<0.001).

Table-24: Association between UMV with SGA & LBW:

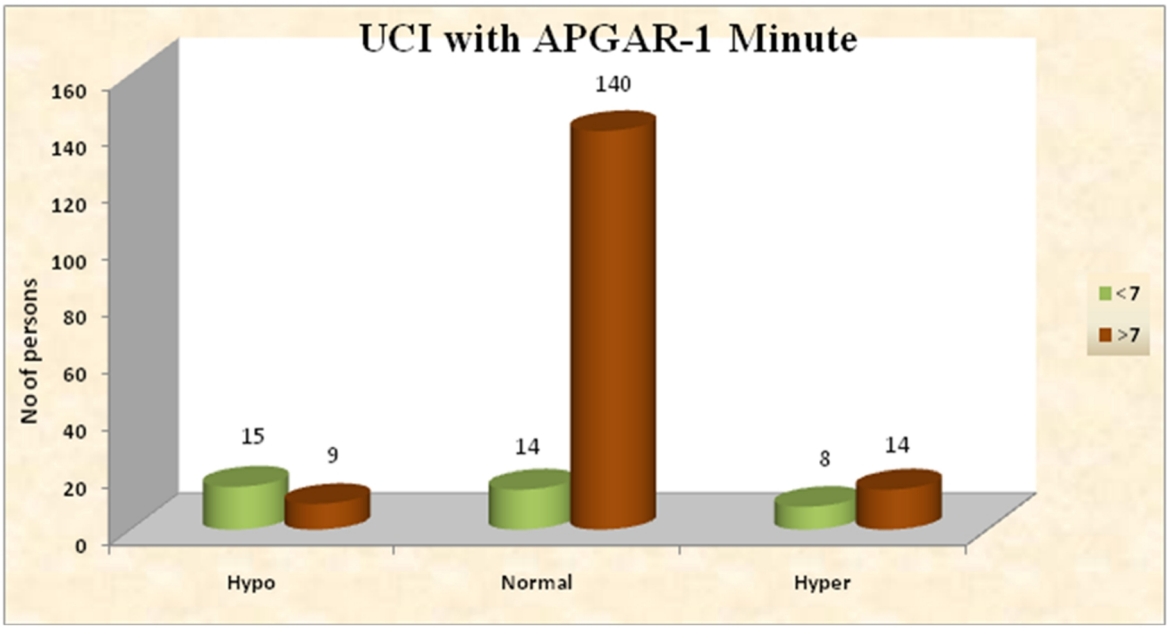
UMV	SGA	LBW	Normal	Total	χ^2	df	Sig
Decreasing	0	12	9	21	94.787	4	P<0.001
Normal	10	9	153	172			
Increasing	7	0	0	7			
Total	17	21	162	200			



The above table -24 states the association between UmV with SGA & LBW. The UmV of decreasing was strongly associated with LBW and UmV of increasing was strongly associated with SGA (P<0.001).

Table-25: Association between UCI with APGAR-1minutes:

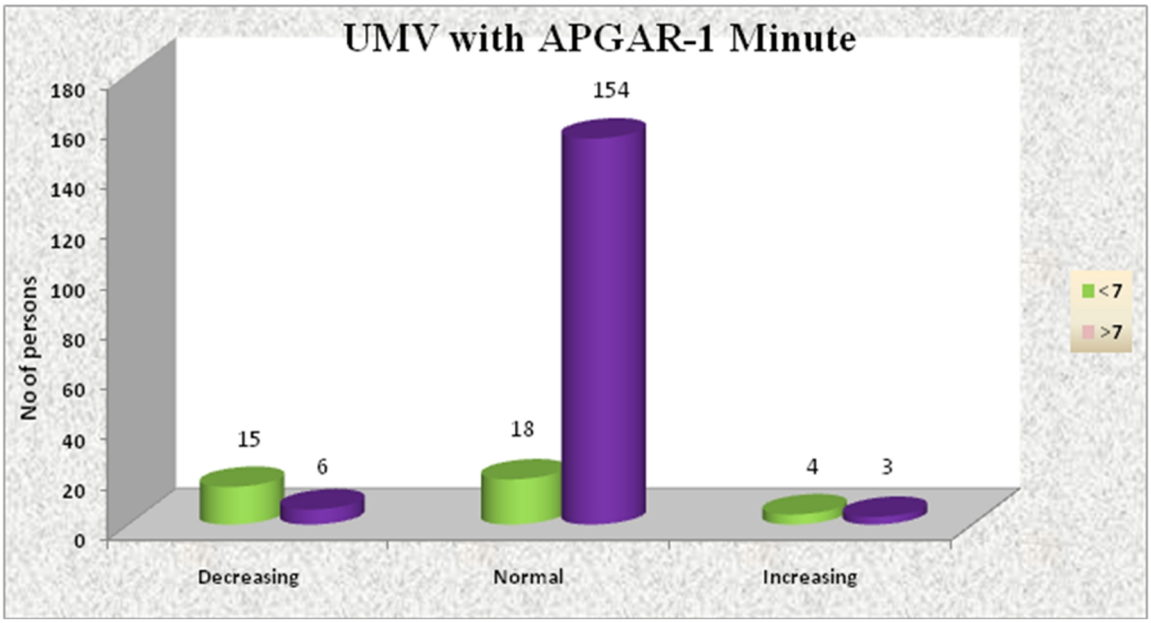
UCI	APGAR score		Total	χ^2	df	Sig
	<7	>7				
Hypo	15	9	24	44.515	2	P<0.001
Normal	14	140	154			
Hyper	8	14	22			
Total	37	163	200			



The above table -25 states the association between UCI with APGAR-1 minutes. The UCI of hypo was strongly associated with <7 APGAR-1minutes. The normal and hyper UCI were associated with >7 APGAR-1minute.

Table-26: Association between UmV with APGAR-1minutes:

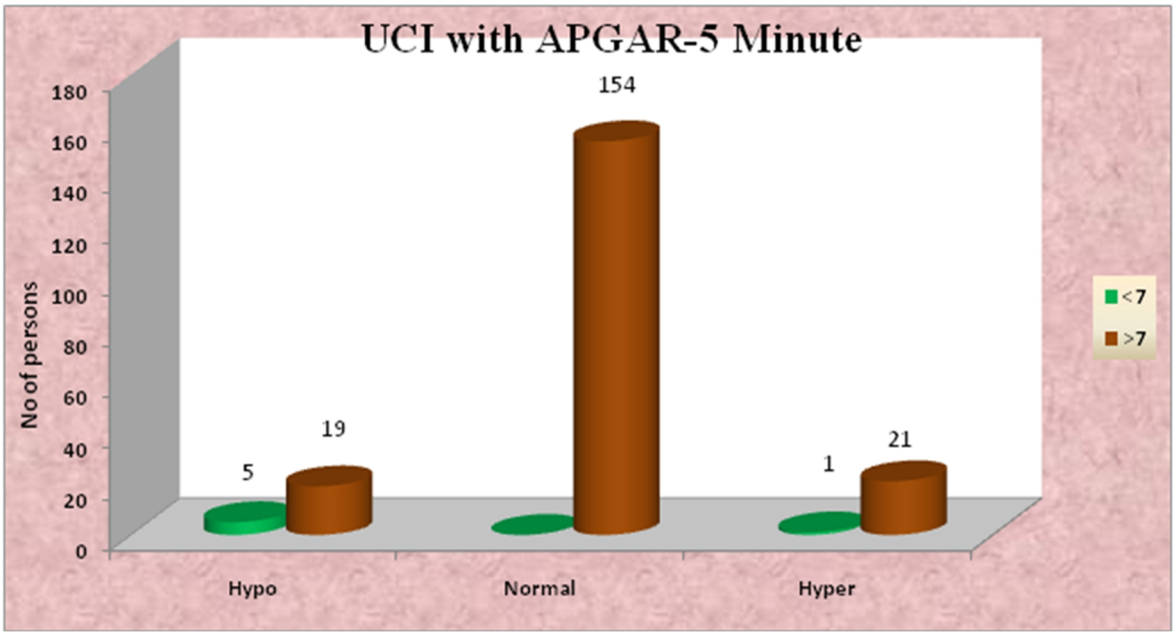
UMV	APGAR		Total	χ^2	df	Sig
	<7	>7				
Decreasing	15	6	21	53.316	2	P<0.001
Normal	18	154	172			
Increasing	4	3	7			
Total	37	163	200			



The above table -26 states the association between UmV with APGAR-1minutes. The UmV of decreasing and increasing were strongly associated with <7 APGAR -1minute. The normal UmV was associated with >7 APGAR-1minute (P<0.001).

Table-27: Association between UCI with APGAR-5minutes:

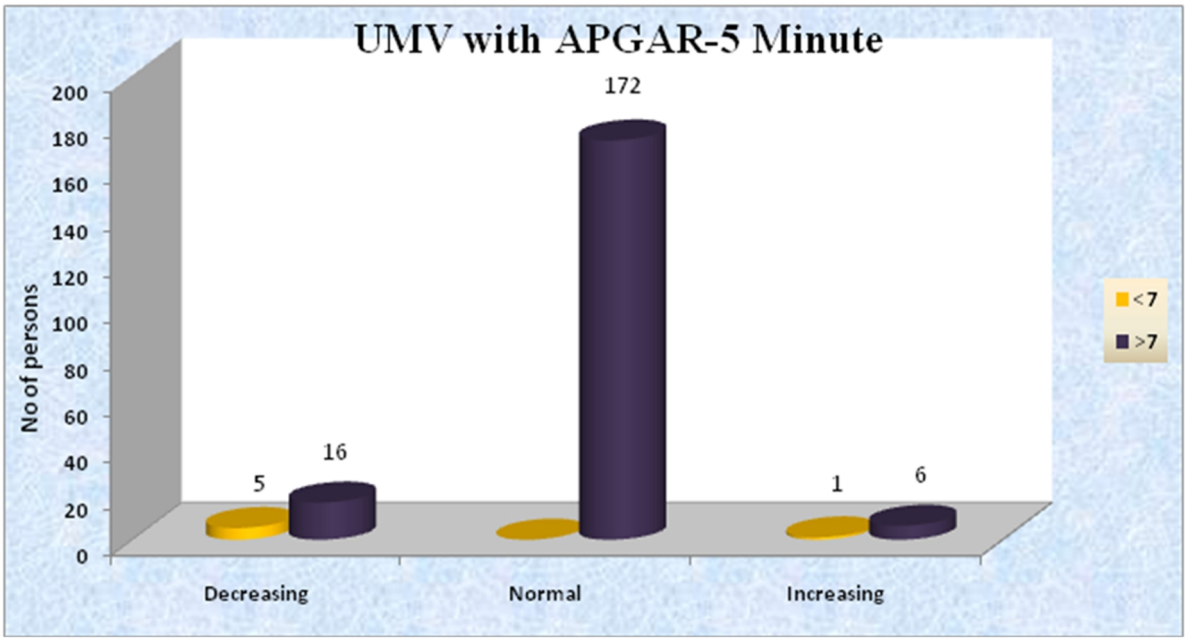
UCI	APGAR		Total	χ^2	df	Sig
	<7	>7				
Hypo	5	19	24	31.173	2	P<0.001
Normal	0	154	154			
Hyper	1	21	22			
Total	6	194	200			



The above table -27 states the association between UCI with APGAR-5 minute. The UCI of hypo was associated with <7 APGAR-5 minute. The normal UCI was strongly associated with >7 APGAR-5 minute. (P<0.001).

Table-28: Association between UmV with APGAR-5minutes:

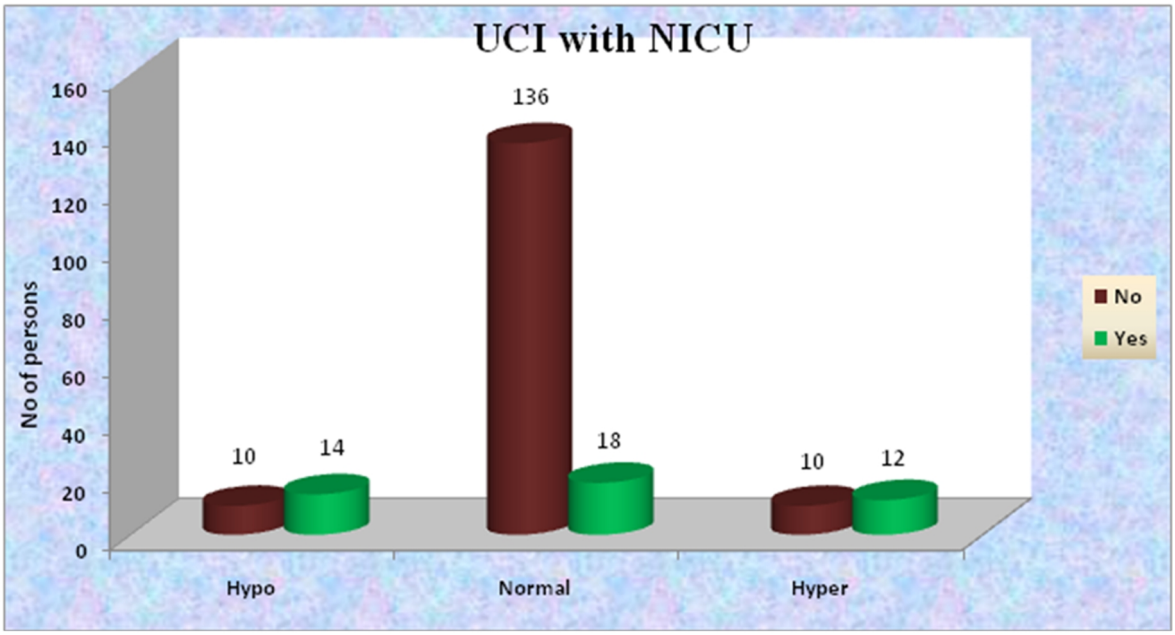
UmV	APGAR		Total	χ^2	df	Sig
	<7	>7				
Decreasing	5	16	21	39.633	2	P<0.001
Normal	0	172	172			
Increasing	1	6	7			
Total	6	194	200			



The above table -28 states the association between UmV with APGAR-5 minute. The UmV of decreasing was associated with <7 APGAR-5 minute. The normal was strongly associated with >7 APGAR-5 minute (P<0.001).

Table-29: Association between UCI with NICU admissions:

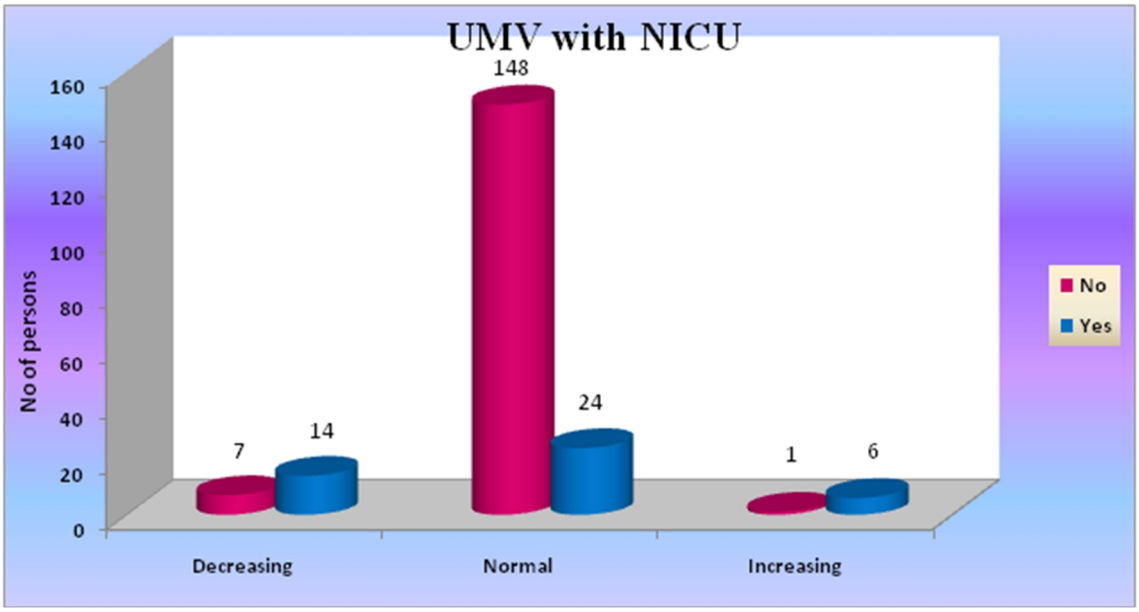
UCI	No	Yes	Total	χ^2	df	Sig
Hypo	10	14	24	41.585	2	P<0.001
Normal	136	18	154			
Hyper	10	12	22			
Total	156	44	200			



The above table -29 states the association between UCI with NICU admissions. The UCI of hypo and hyper were associated with NICU admissions. The normal was strongly associated with non NICU admissions (P<0.001).

Table-30: Association between UmV with NICU admissions:

UmV	No	Yes	Total	χ^2	df	Sig
Decreasing	7	14	21	47.465	2	P<0.001
Normal	148	24	172			
Increasing	1	6	7			
Total	156	44	200			



The above table -30 states the association between UmV with NICU admissions.

The UmV of decreasing and increasing were associated with NICU admissions.

The normal was associated with non NICU admissions (P<0.001).

Table-31: Association between umbilical cord coiling index and umbilical vein blood flow

COILING INDEX / UMBILICAL VEIN BLOOD FLOW	NORMOCOILED	HYPOCOILED	HYPERCOILED	p
NORMAL	154	3	15	0.002
DECREASED	0	21	0	
INCREASED	0	0	7	

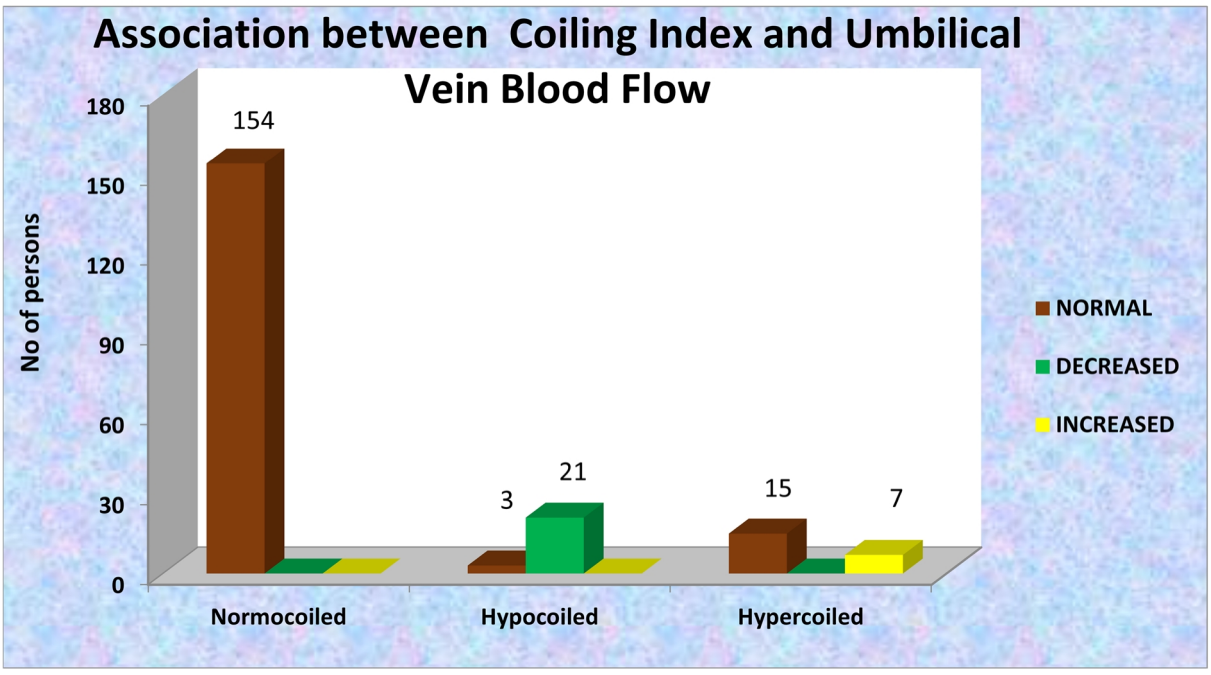


Table-31: Association between umbilical cord coiling index and umbilical vein blood flow. Hypocoiling was associated with decreased umbilical vein blood flow and hypercoiling was associated with increased umbilical vein blood flow.

DISCUSSION

A prospective study was conducted at Tirunelveli Medical College Hospital on sonographic evaluation of umbilical cord coiling index and umbilical vein bood flow in second trimester between 20 to 28 weeks and effect on perinatal outcome.

285 women were recruited in the study out of which 14 had difficulty in calculating coiling index and Doppler characteristics. 30 lost followup, 32 had medical complication and 9 had malpresentation.

200 antenatal mothers who met the inclusion criteria were included in the study. Coiling index and umbilical vein blood flow was determined using ultrasound between 20 to 28 weeks of gestation. Various factors like age, parity, mode of delivery, gestational age at delivery, meconium staining of liquor, CTG abnormalities, intra uterine death, birth weight, APGAR and admission to NICU were observed. The association between these factors and umbilical cord coiling index and umbilical vein blood flow was analyzed using chi square tests and p value < 0.05 was considered significant.

The mean umbilical cord coiling index 0.38. The mean umbilical vein blood flow was 149.88 ml/min. Among the 200 antenatal women included, 154 (77%) were normocoiled, 24 (12%) were hypocoiled and 22 (11%) were hypercoiled. Abnormal blood flow was noted in 27 patients and this accounted

for decreased umbilical vein blood flow noted in 21(10.5%) and increased umbilical vein blood flow noted in 7 (3.5%).

Age

In this study population, about 17 patients were under the age of 20,86 patients were between 20 to 24 years, 69 patients were between 25 to 29 years and 28 patients were above the age of 30.The mean age of mothers was 24.8±4.1 years with minimum age of 17 and maximum age of 37 years. According to the age nearly 43% were in the age group of 20 to 24 years.

28 patients had abnormal umbilical vein blood flow ,4 below the age of 20 had abnormal blood flow and 3 of the patients above the age of 30 had abnormal blood flow.

There was no significant association between maternal age and umbilical vein blood flow.

Obstetric score:

In this study population, there were 113 primigravidas and 87 multigravidas. Among the 113 primigravidas, 79 belonged to the normocoiled group, 17 belonged to the hypocoiled group and 17 belonged to the hypercoiled group. Among the 87 mutigravidas 75 belonged to the normocoiled group, 7

belonged to the hypocoiled group and another 5 belonged to the hypercoiled group. There was statistically no significant association between obstetric score and umbilical cord coiling index.

In 28 women with abnormal umbilical vein blood flow, 22 patients were primigravida and patients 6 were multigravida. There was no statistically significant correlation between obstetric score and umbilical vein blood flow.

The obstetric score didn't determine the umbilical cord coiling index and umbilical vein blood flow in this study.

Gestational Age of Delivery:

Among the study group 181 women delivered at term and 19 women delivered before 37 weeks. 154 women were Normocoiled, 24 women were hypocoiled and 22 women were hypercoiled. 10 out of 24 in the hypocoiled group delivered before 37 weeks whereas 9 out of 154 women in the normocoiled group delivered before 37 weeks of gestation. None of the patients in the hypercoiled group had preterm delivery. There was statistically significant association between umbilical cord coiling index and preterm deliveries. Hypocoiling was associated with preterm deliveries and normocoiling with term deliveries with chi square value 33.587 and a p value of< 0.001.

Out of 28 patients with abnormal umbilical vein blood flow,10 had preterm deliveries . Decreased umbilical vein blood flow was noted in all the 10 preterm deliveries, 9 out of 163 with normal umbilical vein blood flow had

preterm delivery. None of the patients with increased umbilical vein blood flow had preterm deliveries. In this study there was significant association between umbilical vein blood flow and preterm deliveries with p value <0.001. Thus decreased umbilical vein blood flow was associated with preterm deliveries.

In this study there was positive correlation between umbilical cord coiling index and umbilical vein blood flow to gestational age. The UCI determined the gestational age in 9.1% and umbilical vein blood flow in 5.7%.

Thus in this study we found significant association between preterm deliveries to hypocoiled and lean cord. Similar results were found in study by Razak et al, Yung sung et al [13,15], Hypocoiled cords were associated with spontaneous preterm labour and low birth weight [11,12].

Mode of Delivery:

In this study group, 138 women delivered vaginally and 62 delivered by emergency caesarean section. 14 out of 22 women in the hypercoiled group, 9 out of 24 women in the hypocoiled group and 39 out of 154 women in the Normocoiled group delivered by LSCS. Therefore, hypercoiling were significantly associated with increased rate of emergency caesarean sections and normocoiling was associated with normal vaginal deliveries. The chi square value was 33.587 and the p value was <0.001. Similar studies in the past have shown association between operative vaginal deliveries and emergency caesarean section with abnormal coiling index [10,11].

Similarly, out of 28 patients with abnormal umbilical vein blood flow, 17 patients had vaginal delivery and 11 patients had LSCS. We could not find any association between umbilical vein blood flow with mode of delivery.

Abnormal Heart Rate Pattern:

In this study group 151 women had normal heart rate pattern and 41 women had abnormal heart rate patterns during labour. CTG tracing was not applicable in 8 patients, among them 2 was IUD and 6 of them had gestational age less than 32 weeks . 18 out of 154 women in the Normocoiled group, 10 out of 24 women in the hypocoiled group and 13 out of 22 women in the hypercoiled group had abnormal CTG. Thus abnormal heart rate patterns picked up by cardiotocography were significantly associated with hypercoiling and normocoiling was strongly associated with normal fetal heart rate patterns. The p value was <0.001 and the chi square value was 48.634.

Chitra et al, Strong et al and de Laat et al [28,6,7]also showed that fetal heart rate variations were significantly associated with hypercoiling and hypocoiling. This is because the hypocoilied and hypercoiled umbilical cords were less flexible and more prone to kinking and torsion. Hypocoiling pattern, cord thickness and decreased amount of whartons jelly plays an important role in cord susceptibility to outer forces. Hypercoiled cords are more prone for torsion. These abnormal coiling patterns cannot withstand the stress of labour.

Out of 28 women with abnormal umbilical vein blood flow ,9 out of 21with decreased umbilical vein blood flow and 5 out of 7 with increased umbilical vein blood flow had abnormal CTG. Thus, there was significant association between abnormal umbilical vein blood flow pattern and abnormal fetal heart rate pattern, decreased umbilical vein blood flow was associated with abnormal CTG with p value <0.001. Mana et al obtained similar results [24].

Meconium Stained Liquor:

In this study group, 33 women had meconium stained liquor. 17 out of 154 women in the Normocoiled group, 3 out of 24 women in the hypocoiled group and 13 out of 22 women in the hypercoiled group had meconium stained liquor.

There was significant association between hypercoiling and meconium staining of liquor. The p value was <0.001 and the chi square value was 32.578. Many previous studies have found that meconium stained liquor was significantly associated with hypercoiling[15] due to compression mediated flow reduction and predisposition to development of foetoplacental vascular thrombosis[27].

Out of 28 women with abnormal umbilical vein blood flow, 3 out of 21 with decreased umbilical vein blood flow and 5 out of 7 with increased umbilical vein blood flow had meconium staining of liquor. In this study there was significant association between meconium stained liquor to abnormal umbilical vein blood

flow patterns with p value <0.001.Increased umbilical vein blood flow was associated with increased risk of meconium stained liquor.

Intrauterine Death:

There were only 2 cases of intrauterine death and both belonged to the hypocoiled group. These 2 cases had decreased umbilical vein blood flow. There was significant association between hypocoiling and decreased umbilical vein blood flow with intrauterine death. The p value was <0.001. This may be due to the compromise in the foetomaternal circulation in the abnormal cord [(7)].

Gender of the baby:

In this study 109 were male babies and 91 were female babies. We couldn't find any association between umbilical cord coiling index and umbilical vein blood flow to gender of the baby.

Birth Weight:

The average birth weight of the babies in the hypocoiled group was 2.39 kg, hypercoiled group was 2.70 kg and the normocoiled group was 2.83 kg. 6 out of 154 women in the Normocoiled group,2 out of 24 women in the hypocoiled group and 9 out of 22 women in the hypercoiled group had SGA babies whereas 7 out of 154 women in the Normocoiled group, 13 out of 24 women in the hypocoiled group and 1 out of 22 women in the hypercoiled group had Low birth weight babies. There was significant association between hypercoiling with small for gestation age babies and hypocoilin with low birth weight babies . The

chi square value was 72.22 and the p value was <0.001. The incidence of small for gestation babies in the hypercoiled could be due to the thrombosis of the vessels due to increased blood flow and low birth weight babies in the hypocoiled might be due to increased incidence of preterm labour.

Similar result was showed by Yung sung et al. Rana et al, Raio et al and de Laat[13,8,21,7] et al found low birth weight babies to be significantly associated with abnormal coiling index. Many authors have shown significant association between hypercoiling and intrauterine growth restriction [12,24].

Out of 28 women with abnormal umbilical vein blood flow, 12 out of 21 with decreased umbilical vein blood flow had low birth weight babies and 9 out of 172 with normal umbilical vein blood flow had LBW babies. 7 out of 7 women with increased umbilical vein blood flow had small for gestation babies. There was significant association between umbilical vein blood flow and birth weight of babies with chi square value of 94.787 and p value <0.001.

Thus in this study, there was significant association between hypocoiling and decreased umbilical vein blood flow with low birth weight babies, hypercoiling and increased umbilical vein blood flow with small for gestation age babies. There was significant correlation between umbilical cord coiling index and umbilical vein blood flow to birth weight of babies, coiling index determined the birth weight in 8.6% and umbilical vein blood flow determined the birth weight of babies in 4.9%.

Similar studies in the past had same results [24,26].De Laat et[7] al in his study have found significant increase in the risk for small for gestational age and interventional delivery for non-reassuring fetal status among hypercoiled.

APGAR:

In this study, babies of 37 patients had abnormal APGAR scores of <7 at 1 minute. 15 out of 24 babies of the hypocoiled group and 8 out of 22 babies of the hypercoiled group and 14 out of 154 babies of the normocoiled group had abnormal APGAR scores. There was significant association between hypocoiling, hypercoiling and low APGAR scores at 1 minute

Similary , 15 out of 21 with decreased umbilical vein blood flow ,4 out of 7 with increased umbilical vein blood flow and 18 out of 154 with normal umbilical vein blood flow had low APGAR score of <7 at 1 minute. Thus in this study both increased and decreased umbilical vein blood flow was associated with low APGAR score of <7 at 1 minute.

Similarly 5 out 24 in the hypocoiled group and 1 out of 22 in the hypercoiled group had low APGAR of <7 at 5 minutes. None of the babies in the normocoiled group had low APGAR . Hypocoiling was associated with low APGAR of <7 at 5 minutes and normocoiling was strongly associated with APGAR >7 at 5 mins.

Out of 28 patients with abnormal umbilical vein blood flow ,5 out of 21 with decreased umbilical vein blood flow and 1 out of 7 with decreased umbilical

vein blood flow had low APGAR of <7 at 5mins. Thus decreased umbilical vein blood flow was associated with low APGAR.

The results revealed that the UCI determined the APGAR1 and 5 minutes 2.0% each. The increase were very highly statistically significant (P<0.001). The Umbilical vein blood flow determined APGAR-1 and 5 minutes as 13.5% and 7.8% respectively.

There was significant association between abnormal umbilical vein blood flow abnormal umbilical cord coiling index with low APGAR in babies with p value <0.001. Similar findings were shown by many authors[7,8,11,14].

NICU Admission:

Among the babies of the study group, 44 were admitted in new born intensive care unit for various reasons. 14 of the babies of the hypocoiled group, 12 of the babies of the hypercoiled group and 18 of the babies of the normocoiled group had NICU admission. Thus admission of babies to new born unit was more frequent in both hypocoiled and hypercoiled group and there was significant association. The chi square value was 41.585 and p value of <0.001. These results were similar to observations made by Gupta et al and Chitra et al in their studies[27,28].

Out of 28 women with abnormal umbilical vein blood flow, 14 out of 21 with decreased umbilical vein blood flow and 6 out of 7 with increased umbilical vein blood flow had NICU admission. There was significant association between

abnormal umbilical vein blood flows and increased NICU admissions. The chi square value was 47.465 and the p value was <0.001. Thus increased new born admission could be due to the preterm labour, fetal distress due to the meconium aspiration and various other reasons.

Many authors have found that hypocoiling and lean cord co exist because of decreased amount of Whartons jelly and marked segmental thinning of umbilical cord vessels making it more prone for low APGAR, more NICU admissions, low birth weight babies, abnormal fetal heart rate pattern[11,14,26,27].

UCI and Umbilical Vein Blood Flow:

In this study 28 patients had abnormal umbilical vein blood flow. Among them 21 belonged to the hypocoiled group and 7 belonged to the hypercoiled group. There was significant association between umbilical cord coiling index and umbilical vein blood flow. Hypocoiled Cord had decreased umbilical vein blood flow and hypercoiled cord increased umbilical vein blood flow compared to the normocoiled. The umbilical cord coiling index determined the umbilical vein blood flow in 4.9% and there was positive correlation between umbilical cord coiling index and umbilical vein blood flow. The p value was 0.002

Degani et al[22] in his study demonstrated that umbilical vein blood flow is decreased with decreased umbilical cord coiling index. The umbilical coiling modulates the blood flow such that increased coiling bidirectionally stimulates and increases blood conveyance. The direct correlation between increased coiling and increased blood flow could be explained by piston effect[23,24].

Di Naro et al reported that thinner or leaner umbilical cords were significantly associated with decreased antenatal umbilical cord coiling index, cord cross-sectional area (thickness), amount of whartons jelly and venous blood flow volume[18].

SUMMARY

- In this study 200 antenatal patients who met the inclusion criteria were included in the study.
- The umbilical cord coiling index and its Doppler flow characteristics were detected by the USG between 20 to 28 weeks. The mean umbilical cord was 0.38, and the mean umbilical vein blood flow was 149.88 ml/min.
- 154 patients belonged to the normocoiled group, 24 patients belonged to hypocoiled group, 22 belonged to the hypercoiled group. Of the 200, 172 had normal umbilical vein blood flow and 28 had abnormal blood flow.
- These patients were followed up and details regarding the mode of delivery, gestational age of delivery, colour of liquor, fetal heart rate abnormalities, birth weight, APGAR, NICU admissions were noted and the data was analyzed.
- In this study there was correlation between umbilical cord coiling index and umbilical vein blood flow, showing that coiling index determines the umbilical vein blood flow.
- Hypocoiling was associated with decreased umbilical vein blood flow and hypercoiling was associated with increased umbilical vein blood flow.

- There was no association between maternal age, parity to umbilical cord coiling index and umbilical vein blood flow.
- Abnormal fetal heart rate patterns, meconium stained liquor, emergency Lscs , small for gestation babies were significantly associated with hypercoiling.
- Preterm deliveries, low birth weight babies, intrauterine death, poor APGAR was significantly associated with hypocoiling .
- Increased umbilical vein blood flow was associated with small for gestation babies, meconium stained liquor and abnormal foetal heart rate paatterns.
- Decreased umbilical vein blood flow was associated with preterm deliveries ,low birth weight babies, poor APGAR score.
- There was significant association between abnormal umbilical vein blood flow to meconium stained liquor , birth weight of babies and increased NICU admissions.
- There was positive correlation between umbilical coiling index and umbilical vein blood flow to APGAR score, birth weight and gestational age.

- Therefore abnormal umbilical cord coiling index and abnormal umbilical vein blood flow are associated with adverse perinatal outcome.

CONCLUSION

Umbilical cord coiling index and its Doppler flow characteristics should be part of antenatal ultrasound. The abnormal umbilical coiling and abnormal umbilical vein blood flow detected during antenatal period could predict adverse perinatal outcomes and would be useful to select pregnancies for intensified fetal monitoring.

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நோயாளிகளுக்கு அறிவிப்பு மற்றும் ஒப்புதல் படிவம்
(மருத்துவ ஆய்வில் பங்கேற்பதற்கு)

ஆய்வு செய்யப்படும் தலைப்பு:
பங்கு பெறுவரின் பெயர்:
பங்கு பெறுவரின் வயது:

		பங்கு பெறுவர் இதனை ✓ குறிக்கவும்
1.	நான் மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்களை படித்து புரிந்து கொண்டேன். என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டுள்ளது என அறிந்து கொண்டேன்.	☐
2.	நான் இவ்வாய்வில் தன்னிச்சையாக தான் பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த கட்டத்திலும், எந்த சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்து கொண்டேன்.	☐
3.	இந்த ஆய்வு சம்பந்தமாகவோ, இதை சார்ந்து மேலும் ஆய்வு மேற்காள்ளும் போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். நான் ஆய்வில் இருந்து விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன்.	☐
4.	இந்த ஆய்வின் மூலம் கிடைக்கும் தகவலையோ, முடிவையோ பயன்படுத்திக் கொள்ள மறுக்க மாட்டேன்.	☐
5.	இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக் கொள்கிறேன் எனக்கு கொடுக்கப்பட்டஅறிவுரைகளின் படி நடந்து கொள்வதுடன், ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்று உறுதியளிக்கிறேன். என் உடல் நலம் பாதிக்கப்பட்டாலோ, அல்லது எதிர்பாராத, வழக்கத்திற்கு மாறான நோய்குறி தென்பட்டாலோ உடனே இதை மருத்துவ அணியிடம் தெரிவிப்பேன் என உறுதி அளிக்றேன்.	☐

பங்கேற்பவரின் கையொப்பம் / ..... இடம் .....
கட்டைவிரல் ரேகை
பங்கேற்பவரின் பெயர் மற்றும் விலாசம் .....
ஆய்வாளரின் கையொப்பம் /..... இடம் .....
ஆய்வாளரின் பெயர் .....
மையம் .....
கல்வியறிவு இல்லாதவற்கு (கைரேகை வைத்தவர்களுக்கு) இது அவசியம் தேவை
சாட்சியின் கையொப்பம் /..... இடம் .....
பெயர் மற்றும் விலாசம் ....

Sl. No.	IP NO	Age in years	Code	An UCI	UCI	UMV (ml/min)	inference of UMV	GA at delivery	Term/ Preterm	Mode of Delivery	CTG	MSL	IUD	Sex of baby	Birth weight(kg)	SGA /LBW	APGAR		NICU
																	At 1 min	At 5 min	
1	24404	20	PRIMI	0.25	HYPO	60	DEC	36W	PRETERM	NVD	N	-	-	F	2.5	-	6	7	+
2	23075	29	G2P1L1	0.39	NORMO	106.2	N	38W6D	TERM	LSCS	N	-	-	F	3.26	-	7	9	-
3	22358	24	G2P1L1	0.34	NORMO	132.2	N	39W	TERM	LSCS	N	-	-	M	3.3	-	7	8	-
4	22359	26	PRIMI	0.42	HYPER	148.3	N	37W 5D	TERM	NVD	N	+	-	M	2.8	-	7	8	-
5	233347	19	G2P1L1	0.36	NORMO	63.8	N	39W2D	TERM	NVD	N	-	-	M	3	-	7	8	-
6	23745	24	G2P1L1	0.38	NORMO	169.2	N	39W4D	TERM	NVD	N	-	-	F	2.7	-	7	8	-
7	20021	27	G2A1	0.4	NORMO	112.5	N	39W3D	TERM	NVD	N	-	-	F	2.55	SGA	7	8	
8	23699	23	PRIMI	0.24	HYPO	66.3	DEC	36W 4D	PRETERM	NVD	N	-	-	F	2.5	-	6	7	+
9	23561	25	PRIMI	0.4	NORMO	170.9	N	39W 2D	TERM	NVD	ABN	-	-	M	2.8	-	7	8	-
10	23701	31	PRIMI	0.4	NORMO	92.2	N	37W1D	TERM	LSCS	ABN	-	-	M	2.6	-	7	8	-
11	21661	22	G3P1L1 A1	0.44	HYPER	157.1	INC	39W 5D	TERM	NVD	ABN	+	-	M	2.3	SGA	3	5	+
12	23588	23	G3P1L1 A1	0.39	NORMO	149.3	N	39W1D	TERM	NVD	N	-	-	F	2.8	-	7	9	-
13	23126	24	PRIMI	0.38	NORMO	220.2	N	39W2D	TERM	NVD	N	-	-	M	2.4	SGA	7	9	-
14	23488	21	PRIMI	0.37	NORMO	130.2	N	40W1D	TERM	LSCS	N	+	-	F	3	-	7	8	-
15	23444	32	PRIMI	0.36	NORMO	100.1	N	34W2D	PRETERM	NVD	N	-	-	M	2.3	-	6	8	+
16	23452	28	G3P1L1 A1	0.4	NORMO	168.9	N	38W 4D	TERM	NVD	N	-	-	M	2.8	-	7	8	-
17	21077	25	G4P1L1 A2	0.23	HYPO	61.2	DEC	39W 2D	TERM	LSCS	ABN	+	-	F	2.6	SGA	6	8	+
18	20559	21	PRIMI	0.35	NORMO	152.3	N	39W6D	TERM	NVD	N	-	-	M	2.52	SGA	7	8	-
19	23076	22	G2P1L1	0.35	NORMO	170.9	N	36W2D	PRETERM	NVD	N	-	-	M	2.4	-	7	8	-
20	20872	22	PRIMI	0.48	HYPER	180.5	INC	38W 2D	TERM	NVD	ABN	+	-	M	2.54	SGA	7	8	+
21	232692	25	G2P1L1	0.36	NORMO	112.3	N	37W	TERM	NVD	N	-	-	M	2.8	-	7	8	-
22	23280	23	G2A1	0.37	NORMO	96.3	N	37W6D	TERM	NVD	N	-	-	M	2.65	-	7	8	-
23	23600	26	G2P1L1	0.38	NORMO	170.1	N	40W	TERM	NVD	N	+	-	F	2.5	LBW	7	8	+

24	23895	22	PRIMI	0.39	NORMO	220.2	N	36W2D	PRETERM	NVD	N	-	-	F	2.52	-	7	8	-
25	22799	27	PRIMI	0.4	NORMO	119.4	N	39W4D	TERM	NVD	N	-	-	F	2.9	-	7	8	-
26	22354	21	PRIMI	0.18	HYPO	66.6	DEC	38W 3D	TERM	LSCS	N	-	-	F	2.55	SGA	7	8	+
27	24188	22	PRIMI	0.4	NORMO	169.9	N	37W2D	TERM	NVD	N	-	-	M	3	-	7	8	-
28	24180	21	G2P1L1	0.39	NORMO	126.5	N	37W 5D	TERM	NVD	N	+	-	M	2.75	-	7	8	+
29	24191	27	PRIMI	0.38	NORMO	77.9	N	37W 6D	TERM	LSCS	ABN	+	-	M	2.6	-	6	7	+
30	22153	27	PRIMI	0.52	HYPER	145.7	N	38W 5D	TERM	LSCS	N	-	-	M	2.54	SGA	8	9	-
31	24619	30	G2P1L1	0.4	NORMO	220.9	N	40W	TERM	NVD	N	-	-	F	3.4	-	8	9	-
32	22846	24	PRIMI	0.37	NORMO	112.2	N	39W 5D	TERM	NVD	N	-	-	F	2.9	-	7	8	-
33	23428	26	G2A1	0.36	NORMO	147.3	N	38W 5D	TERM	NVD	N	-	-	F	3.3	-	7	8	-
34	20340	33	PRIMI	0.12	HYPO	28.2	DEC	38W 3D	TERM	LSCS	ABN	-	-	M	2.4	LBW	7	9	-
35	22478	25	PRIMI	0.38	NORMO	170.9	N	38W	TERM	NVD	N	-	-	F	2.8	-	7	8	-
36	21760	22	PRIMI	0.39	NORMO	98.4	N	39W 4D	TERM	NVD	N	-	-	M	3.4	-	7	8	-
37	24252	25	G2P1L1	0.38	NORMO	79.4	N	38W 1D	TERM	NVD	N	+	-	M	3.2	-	7	8	-
38	22467	26	PRIMI	0.46	HYPER	116.2	INC	40W 3D	TERM	LSCS	ABN	+	-	M	2.54	SGA	6	8	+
39	21492	24	PRIMI	0.4	NORMO	98.4	N	39W 4D	TERM	NVD	N	-	-	F	3.1	-	7	9	-
40	24198	28	PRIMI	0.4	NORMO	159.4	N	37W	TERM	NVD	N	-	-	F	2.8	-	7	8	-
41	23808	27	PRIMI	0.36	NORMO	130.2	N	39W 4D	TERM	NVD	N	-	-	F	3	-	7	9	-
42	22648	19	PRIMI	0.15	HYPO	71.3	DEC	36W 1D	PRETERM	NVD	N	-	-	F	2.5	-	8	9	-
43	23751	23	PRIMI	0.38	NORMO	169.9	N	38W 5D	TERM	NVD	N	-	-	M	2.57	SGA	7	8	-
44	24145	34	G2P1L1	0.36	NORMO	135.4	N	38W	TERM	NVD	N	-	-	F	3.4	-	7	8	-
45	24273	24	PRIMI	0.47	HYPER	152.2	INC	39W 4D	TERM	NVD	ABN	+	-	F	2.6	SGA	3	8	+
46	23004	32	PRIMI	0.38	NORMO	98.9	N	39W 2D	TERM	LSCS	N	-	-	F	3.1	-	7	8	-
47	24310	24	G2A1	0.4	NORMO	219.2	N	40W 2D	TERM	NVD	N	-	-	M	2.7	-	7	8	-
48	24397	21	PRIMI	0.38	NORMO	150.2	N	38W 4D	TERM	NVD	N	-	-	M	2.4	SGA	7	8	-
49	24404	25	G3P1L1A1	0.36	NORMO	78.4	N	39W 3D	TERM	NVD	N	-	-	F	2.8	-	7	8	-
50	27116	31	PRIMI	0.14	HYPO	16.5	DEC	35W 3D	PRETERM	NVD	N	-	IUD	F	1.85	LBW	0	0	-

51	24385	23	G4P1L1A2	0.37	NORMO	126.4	N	37W 2D	TERM	NVD	N	-	-	M	3	-	7	8	-
52	24412	27	PRIMI	0.38	NORMO	219.9	N	39W 2D	TERM	NVD	N	-	-	F	2.8	-	7	8	-
53	22627	24	PRIMI	0.49	HYPER	134.5	N	38W	TERM	NVD	N	+	-	M	2.6	SGA	7	8	-
54	24330	34	PRIMI	0.4	NORMO	126.7	N	39W 1D	TERM	NVD	ABN	+	-	F	3.1	-	6	8	+
55	24131	21	G2A1	0.4	NORMO	170.3	N	37W 6D	TERM	NVD	N	-	-	M	2.7	-	8	9	-
56	24416	17	PRIMI	0.38	NORMO	67.2	N	40W 3D	TERM	NVD	N	-	-	M	2.9	-	7	9	-
57	24399	37	PRIMI	0.39	NORMO	194.5	N	38W 4D	TERM	LSCS	N	-	-	F	2.7	-	7	9	-
58	22737	20	PRIMI	0.19	HYPO	69.9	DEC	32W 2D	PRETERM	NVD	-	-	-	M	1.6	LBW	6	8	+
59	24130	21	G2P1L1	0.38	NORMO	112.6	N	39W 1D	TERM	NVD	N	-	-	M	2.5	SGA	7	8	-
60	24189	24	G2P1L1	0.39	NORMO	95.8	N	40W 4D	TERM	NVD	N	-	-	F	2.8	-	8	9	-
61	24456	27	PRIMI	0.37	NORMO	147.2	N	39W 3D	TERM	NVD	N	-	-	F	3.2	-	8	9	-
62	21959	17	PRIMI	0.45	HYPER	150.3	N	40W	TERM	LSCS	ABN	+	-	M	2.7	-	7	8	-
63	24489	29	PRIMI	0.38	NORMO	219.4	N	39W 4D	TERM	NVD	N	-	-	F	3.2	-	8	9	-
64	23574	23	G3P1L1A1	0.4	NORMO	109.2	N	38W 3D	TERM	NVD	N	-	-	M	3.1	-	7	9	-
65	24347	24	PRIMI	0.39	NORMO	149.4	N	40W	TERM	LSCS	ABN	-	-	F	2.8	-	8	9	-
66	28232	22	PRIMI	0.18	HYPO	34.6	DEC	34W 6D	PRETERM	NVD	N	-	-	M	2.2	-	6	7	+
67	10696	22	PRIMI	0.4	NORMO	79.4	N	38W 5D	TERM	LSCS	N	+	-	F	2.7	-	7	8	+
68	10733	28	PRIMI	0.38	NORMO	119.2	N	39W 4D	TERM	NVD	N	-	-	M	2.4	LBW	8	9	-
69	22813	22	PRIMI	0.44	HYPER	127.7	INC	38W	TERM	NVD	N	-	-	M	2.6	SGA	7	8	+
70	10588	26	G3P2L2	0.4	NORMO	194.3	N	38W 3D	TERM	NVD	N	-	-	M	2.9	-	7	9	-
71	11037	17	PRIMI	0.4	NORMO	120.2	N	37W 3D	TERM	NVD	N	-	-	M	2.65	-	7	8	-
72	10418	20	G3A2	0.39	NORMO	172.4	N	39W 3D	TERM	LSCS	ABN	-	-	F	2.8	-	7	8	-
73	114242	25	G2P1L1	0.38	NORMO	100.2	N	40W 3D	TERM	NVD	N	+	-	M	3	-	6	8	+
74	28731	26	G2P1L1	0.22	HYPO	63.8	DEC	32W 2D	PRETERM	NVD	-	+	-	F	2.1	LBW	6	8	+
75	10930	31	G3P1L1A1	0.37	NORMO	211.2	N	38W 6D	TERM	NVD	N	-	-	F	3.1	-	7	8	+
76	11075	19	PRIMI	0.39	NORMO	222.3	N	38W 5D	TERM	LSCS	N	-	-	F	3.2	-	7	9	-
77	10791	24	PRIMI	0.4	NORMO	152.5	N	39W 6D	TERM	NVD	N	-	-	M	2.9	.	7	8	-

78	22928	32	G2P1L1	0.59	HYPER	218.9	N	38W	TERM	NVD	ABN	-	-	F	3.21	-	7	8	+
79	11646	22	PRIMI	0.4	NORMO	119.1	N	40W	TERM	NVD	N	-	-	M	2.7	-	7	9	-
80	24454	18	PRIMI	0.39	NORMO	180.2	N	40W	TERM	LSCS	N	-	-	F	2.8	-	7	8	-
81	23673	20	PRIMI	0.4	NORMO	133.5	N	40W 2D	TERM	NVD	N	-	-	F	2.8	-	7	9	-
82	30746	24	PRIMI	0.21	HYPO	66.3	DEC	36W 4D	PRETERM	NVD	N	-	-	F	2.5	-	7	8	-
83	236992	22	G2P1L1	0.4	NORMO	200.4	N	38W 6D	TERM	NVD	N	+	-	M	2.8	-	6	8	+
84	23474	24	G2A1	0.38	NORMO	111.9	N	38W 1D	TERM	NVD	N	-	-	M	3.1	-	7	8	-
85	22804	30	PRIMI	0.58	HYPER	90.1	N	37W	TERM	LSCS	ABN	+	-	M	2.3	LBW	6	8	+
86	21846	26	PRIMI	0.4	NORMO	219.4	N	38W 2D	TERM	LSCS	N	-	-	M	2.4	LBW	7	8	-
87	23551	28	G3P1L1 A1	0.41	NORMO	184.1	N	37W 4D	TERM	NVD	N	-	-	M	2.7	-	7	9	-
88	24597	27	PRIMI	0.4	NORMO	132.3	N	39W 5D	TERM	NVD	N	-	-	M	2.8	-	7	8	-
89	24690	25	G2P1L1	0.39	NORMO	156.7	N	38W 3D	TERM	NVD	N	-	-	M	2.7	-	7	9	-
90	23564	22	PRIMI	0.38	NORMO	138.4	N	38W	TERM	NVD	N	-	-	M	2.8	-	7	8	-
91	28548	22	PRIMI	0.26	HYPO	74.3	DEC	31W 2D	PRETERM	NVD	-	-	-	F	2.2	LBW	7	8	-
92	24497	25	G2A1	0.36	NORMO	221.1	N	39W 1D	TERM	NVD	N	-	-	F	2.9	-	7	8	-
93	24576	24	PRIMI	0.38	NORMO	164.2	N	38W 4D	TERM	NVD	N	-	-	M	2.7	-	7	9	-
94	24826	26	PRIMI	0.39	NORMO	186.2	N	40W	TERM	LSCS	N	-	-	M	2.8	-	7	8	-
95	23104	31	G2P1L1	0.72	HYPER	98.63	N	38W 3D	TERM	LSCS	ABN	+	-	M	2.54	SGA	6	7	+
96	24900	18	PRIMI	0.4	NORMO	109.2	N	37W 6D	TERM	LSCS	N	-	-	F	3.2	-	7	8	-
97	24711	28	G3P2L2	0.42	NORMO	132.1	N	38W 5D	TERM	NVD	N	+	-	M	3	-	7	8	-
98	24918	25	PRIMI	0.41	NORMO	211	N	34W 6D	PRETERM	NVD	-	-	-	M	1.8	LBW	6	7	+
99	24837	22	PRIMI	0.38	NORMO	133.1	N	38W 1D	TERM	LSCS	N	-	-	M	2.7	-	7	8	-
100	35747	19	PRIMI	0.14	HYPO	18.5	DEC	30W 4D	PRETERM	NVD	-	-	IUD	M	1.3	LBW	-	-	-
101	24843	23	PRIMI	0.39	NORMO	1224.5	N	40W 3D	TERM	NVD	N	-	-	M	3.1	-	7	9	-
102	23820	29	G4P1L1 A2	0.38	NORMO	180.45	N	38W	TERM	NVD	N	-	-	F	2.8	-	7	9	-
103	23814	22	PRIMI	0.37	NORMO	223.45	N	37W 5D	TERM	NVD	N	-	-	F	2.7	-	7	8	-
104	22931	21	PRIMI	0.63	HYPER	152.1	INC	38W 5D	TERM	LSCS	ABN	-	-	M	2.53	SGA	7	8	+

105	24258	28	G2P1L1	0.38	NORMO	113.65	N	38W 6D	TERM	NVD	N	-	-	M	2.7	-	7	9	-
106	24306	23	PRIMI	0.39	NORMO	134.5	N	37W2D	TERM	NVD	N	-	-	M	2.8	-	8	9	-
107	25072	27	PRIMI	0.37	NORMO	212.3	N	38W 4D	TERM	LSCS	ABN	-	-	M	2.8	-	8	9	-
108	23113	19	PRIMI	0.24	HYPO	71.9	DEC	38W 4D	TERM	LSCS	ABN	-	-	F	2.4	LBW	6	8	+
109	15072	24	PRIMI	0.38	NORMO	101.23	N	38W 6D	TERM	NVD	N	-	-	F	3.2	-	8	9	-
110	16315	20	PRIMI	0.4	NORMO	143.32	N	39W 5D	TERM	NVD	N	-	-	F	3	-	8	9	-
111	15683	25	G2A1	0.37	NORMO	157.67	N	37W 6D	TERM	NVD	N	-	-	M	2.8	-	7	8	-
112	16408	33	PRIMI	0.41	NORMO	156.34	N	39W 4D	TERM	NVD	N	-	-	M	2.9	-	6	7	+
113	22775	19	PRIMI	0.54	HYPER	267.2	INC	37W 4D	TERM	LSCS	N	+	-	F	2.54	SGA	5	7	+
114	16259	26	G2P1L1	0.41	NORMO	120.3	N	39W 4D	TERM	LSCS	ABN	-	-	M	3.2	-	7	9	-
115	16912	25	G3P1L1 A1	0.38	NORMO	204.22	N	37W 5D	TERM	NVD	N	-	-	F	2.87	-	7	8	-
116	16632	29	PRIMI	0.42	NORMO	165.34	N	39W 4D	TERM	NVD	N	-	-	F	2.9	-	8	9	-
117	16248	22	PRIMI	0.4	NORMO	246.63	N	38W 6D	TERM	NVD	N	-	-	M	3.1	-	7	9	-
118	16896	25	PRIMI	0.39	NORMO	170.89	N	40W 2D	TERM	NVD	N	-	-	M	3	-	7	8	-
119	17110	21	G2A1	0.38	NORMO	127.8	N	39W 2D	TERM	LSCS	ABN	+	-	M	3.4	-	5	7	+
120	22763	30	G2P1L1	0.22	HYPO	210.5	N	37W 2D	TERM	NVD	N	-	-	F	2.4	LBW	7	8	-
121	24303	24	G2P1L1	0.37	NORMO	127.8	N	40W	TERM	NVD	N	-	-	F	2.8	-	7	9	-
122	25067	26	G2P1L1	0.38	NORMO	206.54	N	39W 3D	TERM	NVD	N	-	-	F	2.9	-	8	9	-
123	24957	18	PRIMI	0.36	NORMO	179.9	N	38W 5D	TERM	LSCS	ABN	-	-	M	2.8	-	7	8	-
124	23410	21	G2P1L1	0.62	HYPER	149.4	N	38W 5D	TERM	LSCS	N	-	-	M	2.9	-	7	8	-
125	24461	19	PRIMI	0.39	NORMO	156.78	N	38W 4D	TERM	LSCS	N	+	-	M	2.8	-	7	8	-
126	34675	29	G3P2L2	0.39	NORMO	122.21	N	39W 4D	TERM	NVD	N	-	-	M	3.2	-	7	8	-
127	34617	27	PRIMI	0.37	NORMO	146.88	N	38W 3D	TERM	NVD	N	-	-	M	2.8	-	8	9	-
128	33264	26	G3P1L1 A1	0.38	NORMO	196.55	N	40W 3D	TERM	NVD	N	-	-	F	3.2	-	7	9	-
129	21979	31	G2P1L1	0.29	HYPO	198.8	N	39W	TERM	NVD	N	-	-	M	2.5	-	7	8	-
130	34915	23	G2P1L1	0.4	NORMO	162.23	N	39W 5D	TERM	NVD	N	-	-	F	2.7	-	7	8	-

131	35015	21	PRIMI	0.4	NORMO	201.23	N	39W 1D	TERM	NVD	N	-	-	F	2.9	-	8	9	-
132	34888	22	G2P1L1	0.41	NORMO	98.56	N	38W 6D	TERM	LSCS	N	-	-	M	2.9	-	7	8	-
133	34631	28	G2P1L1	0.58	HYPER	180.9	N	40W 2D	TERM	NVD	N	-	-	F	3.2	-	8	9	-
134	35368	36	G2A1	0.4	NORMO	134.65	N	38W 1D	TERM	LSCS	N	-	-	M	2.8	-	8	9	-
135	32390	32	G3A2	0.39	NORMO	118.9	N	38W 4D	TERM	NVD	N	-	-	M	2.9	-	7	8	-
136	23344	28	PRIMI	0.28	HYPO	75.65	DEC	38W 4D	TERM	LSCS	ABN	+	-	M	2.35	LBW	6	8	+
137	34266	21	PRIMI	0.42	NORMO	140.44	N	40W	TERM	NVD	N	-	-	M	2.9	-	8	9	-
138	35363	22	PRIMI	0.41	NORMO	200.1	N	38W 6D	TERM	NVD	ABN	-	-	F	3	-	8	9	-
139	34180	27	G2P1L1	0.38	NORMO	98.8	N	39W 2D	TERM	NVD	ABN	-	-	M	2.9	-	7	8	-
140	35442	21	PRIMI	0.36	NORMO	189.43	N	38W 4D	TERM	LSCS	N	+	-	F	2.9	-	7	8	-
141	32805	24	PRIMI	0.38	NORMO	154.3	N	39W 4D	TERM	NVD	N	-	-	F	2.87	-	8	9	-
142	35747	31	G2P1L1	0.37	NORMO	198.77	N	38W 2D	TERM	NVD	N	-	-	F	2.9	-	7	8	-
143	36088	26	G3P1L1 A1	0.38	NORMO	133.56	N	39W4D	TERM	NVD	N	-	-	F	3.1	-	8	9	-
144	23173	27	G3A2	0.26	HYPO	63.4	DEC	38W 1D	TERM	LSCS	ABN	-	-	M	2.4	LBW	5	6	+
145	36111	25	G2A1	0.4	NORMO	178.89	N	40W 2D	TERM	LSCS	ABN	-	-	F	2.8	-	7	8	-
146	36299	27	G3P2L2	0.4	NORMO	167.89	N	39W	TERM	NVD	N	-	-	M	2.9	-	7	8	-
147	36371	19	PRIMI	0.42	NORMO	211.56	N	38W 5D	TERM	LSCS	N	-	-	M	2.8	-	8	9	-
148	36561	26	G4P1L1 A2	0.38	NORMO	154.3	N	40W 2D	TERM	LSCS	N	-	-	M	2.8	-	7	8	-
149	21819	31	PRIMI	0.78	HYPER	110.5	N	38W 2D	TERM	LSCS	N	+	-	M	3.8	-	6	8	+
150	36531	24	PRIMI	0.36	NORMO	220.98	N	39W 4D	TERM	NVD	N	-	-	F	3.2	-	8	9	-
151	35745	26	G2P1L1	0.38	NORMO	168.88	N	38W 5D	TERM	NVD	N	-	-	F	2.8	-	7	8	-
152	36171	23	G3P1L1 A1	0.41	NORMO	96.7	N	31W 2D	PRETERM	NVD	-	-	-	F	1.4	LBW	6	7	+
153	37272	21	PRIMI	0.38	NORMO	160.34	N	39W 3D	TERM	LSCS	N	-	-	M	2.7	-	7	8	-
154	22519	21	PRIMI	0.22	HYPO	60.9	DEC	38W 4D	TERM	LSCS	ABN	-	-	F	2.9	-	6	8	+
155	36598	27	G3A2	0.4	NORMO	205.88	N	38W 1D	TERM	NVD	N	-	-	F	2.9	-	7	8	-
156	37404	23	G2P1L1	0.36	NORMO	136.77	N	39W 5D	TERM	NVD	N	-	-	M	2.7	-	7	8	-

157	37154	26	PRIMI	O.38	NORMO	95.78	N	38W 5D	TERM	NVD	N	-	-	M	3	-	7	9	-
158	37577	21	PRIMI	0.39	NORMO	132.87	N	39W 4D	TERM	LSCS	ABN	-	-	M	2.7	-	7	8	-
159	20849	17	PRIMI	0.46	HYPER	94.5	N	39W 2D	TERM	LSCS	ABN	-	-	F	2.9	-	7	8	-
160	35457	25	G2A1	0.4	NORMO	146.88	N	39W 3D	TERM	NVD	N	-	-	M	2.9	-	8	9	-
161	38359	27	G3P1L1 A1	0.36	NORMO	199.78	N	40W	TERM	NVD	N	-	-	F	3.2	-	8	9	-
162	38383	29	G4A3	0.4	NORMO	171.78	N	39W 2D	TERM	LSCS	N	-	-	F	2.9	-	7	8	-
163	23251	19	PRIMI	0.4	NORMO	119.8	N	38W 1D	TERM	NVD	N	-	-	F	2.7	-	7	8	-
164	36079	33	G3P2L2	0.26	HYPO	69.8	DEC	38W 3D	TERM	NVD	ABN	-	-	M	2.4	LBW	5	6	+
165	38714	32	G2P1L1	0.34	NORMO	164.7	N	38W 1D	TERM	LSCS	N	-	-	F	3.1	-	7	8	-
166	23251	20	PRIMI	0.36	NORMO	98.77	N	36W2D	PRETERM	NVD	N	-	-	M	2.6	-	8	9	-
167	23647	22	PRIMI	0.34	NORMO	116.78	N	40W 2D	TERM	NVD	N	-	-	M	2.8	-	7	8	-
168	23658	31	PRIMI	0.54	HYPER	130.2	N	38W 3D	TERM	LSCS	ABN	+	-	F	3	-	6	8	+
169	23588	28	PRIMI	0.38	NORMO	220.56	N	35W 3D	PRETERM	NVD	N	-	-	F	2.5	-	8	9	+
170	23126	25	G2P1L1	0.34	NORMO	118.56	N	38W 6D	TERM	NVD	N	-	-	M	2.9	-	7	8	-
171	23698	24	G2A1	0.4	NORMO	159.8	N	39W 6D	TERM	NVD	N	+	-	F	2.7	-	8	9	-
172	20849	25	G2P1L1	0.18	HYPO	52.9	DEC	37W 5D	TERM	LSCS	ABN	-	-	F	2.3	LBW	6	8	+
173	23280	20	PRIMI	0.4	NORMO	174.56	N	37W 4D	TERM	LSCS	N	-	-	F	2.7	-	7	8	-
174	23600	24	G3A2	0.4	NORMO	213.78	N	38W 5D	TERM	NVD	N	-	-	M	2.9	-	7	9	-
175	23269	19	PRIMI	0.36	NORMO	92.7	N	39W 3D	TERM	NVD	N	-	-	M	2.7	-	5	7	+
176	23650	22	PRIMI	0.49	HYPER	155.7	N	38W 2D	TERM	LSCS	ABN	+	-	F	2.9	-	7	8	-
177	23438	21	PRIMI	0.39	NORMO	156.8	N	37W 2D	TERM	NVD	N	-	-	F	2.8	-	8	9	-
178	23803	27	G2A1	0.36	NORMO	120.89	N	38W 2D	TERM	LSCS	N	-	-	F	3.5	-	8	9	-
179	23701	30	G3P1L1 A1	0.34	NORMO	156.77	N	38W 4D	TERM	LSCS	ABN	+	-	M	3.1	-	6	7	+
180	23479	28	PRIMI	0.29	HYPO	67.8	DEC	38W 5D	TERM	NVD	ABN	+	-	M	2.3	LBW	5	6	+
181	30148	21	PRIMI	0.38	NORMO	97.6	N	39W 4D	TERM	LSCS	N	-	-	F	2.8	-	7	8	-
182	30345	23	G2P1L1	0.36	NORMO	189.9	N	38W 2D	TERM	NVD	N	-	-	M	3	-	8	9	-
183	31383	24	G2A1	0.34	NORMO	166.6	N	40W	TREM	NVD	ABN	-	-	M	3	-	7	9	-

184	23647	34	PRIMI	0.48	HYPER	220.4	N	38W 1D	TERM	LSCS	ABN	-	-	F	2.56	-	7	8	+
185	31947	22	G2P1L0	0.37	NORMO	221.7	N	38W 4D	TERM	NVD	N	-	-	F	2.9	-	8	9	-
186	31088	28	PRIMI	0.39	NORMO	92.4	N	32W 2D	PRETERM	NVD	-	-	-	M	1.6	LBW	6	8	-
187	32011	29	G3P2L2	0.38	NORMO	230	N	39W4D	TERM	NVD	N	-	-	F	2.7	-	7	8	-
188	23708	23	PRIMI	0.24	HYPO	62.4	DEC	38W 1D	TERM	NVD	N	-	-	M	2.7	-	7	8	-
189	31530	26	PRIMI	0.38	NORMO	158.99	N	40W 3D	TERM	NVD	N	-	-	F	3.2	-	8	9	-
190	31234	24	PRIMI	0.4	NORMO	186.7	N	38W 4D	TERM	LSCS	N	-	-	M	2.9	-	7	8	-
191	31969	25	G3P1L1A1	0.35	NORMO	100.2	N	39W 2D	TERM	NVD	N	-	-	M	3.2	-	7	8	-
192	23192	23	PRIMI	0.49	HYPER	149.4	N	38W 4D	TERM	LSCS	N	-	-	M	2.8	-	8	9	-
193	31334	27	G2P1L1	0.4	NORMO	220.1	N	40W 4D	TERM	NVD	N	-	-	F	3.4	-	8	9	-
194	31465	22	PRIMI	0.36	NORMO	91.22	N	32W 1D	PRETERM	NVD	-	-	-	M	2	LBW	6	7	+
195	31643	21	G2P1L0	0.37	NORMO	187.8	N	40W	TERM	NVD	N	-	-	M	2.8	-	7	8	-
196	23075	34	PRIMI	0.22	HYPO	144.3	N	38W 4D	TERM	LSCS	ABN	-	-	M	3.4	-	7	8	-
197	32054	30	G2A1	0.34	NORMO	167.8	N	38W	TERM	LSCS	ABN	-	-	M	3	-	7	8	-
198	32079	32	PRIMI	0.36	NORMO	188.9	N	40W 2D	TERM	LSCS	ABN	+	-	F	3	-	6	7	+
199	32124	24	G2P1L1	0.38	NORMO	212.56	N	39W 4D	TERM	NVD	N	-	-	F	2.9	-	7	8	-
200	32334	22	PRIMI	0.36	NORMO	112.78	N	40W 2D	TERM	LSCS	N	+	-	M	2.9	-	7	8	-

QUESTIONAIRE

NAME : AGE : ID NO.:

ADDRESS :

CONTACT NUMBER :
SOCIO ECONOMIC STATUS:
OBST. SCORE : M/H:
LMP : M/S:
EDD :

GEST. AGE :
PRESENT HISTORY :
OBSTETRIC HISTORY:
FAMILY HISTORY:

GA as per 1st trimester scan:
GA as per LMP:

Medical disorders in the mother:

Hypertension/PIH Epilepsy
Diabetes Mellitus/GDM Thyroid Disturbances
Anaemia Heart Disease

Late Second Trimester Scan:

SLIUG_____ Weeks, _____Presentation
Liquor_____
Anomaly survey
Coiling Index_____
Cord diameter
Foetal weight
Umbilical vein blood flow volume

Clinical Examination:

HEIGHT : cms WEIGHT: kg
PULSE: BLOOD PRESSURE:
PALLOR: **+** / **-** **THYROID:**

CVS: RS:

P/A:

P/V:

Delivery Details:

CTG: Reactive / Non-Reactive

Onset of Labour: Spontaneous / Induced

Color of Liquor: Clear / Meconium Stained

Duration of Labour:
Mode of Delivery: Labour Naturale / Operative Vaginal Delivery / LSCS

(indication:_____)

Baby Details:

Sex: M / F

Birth Weight: _____kgs

APGAR: 1 min_____, 7 mins_____

Admission to NICU:

CONSENT FORM

STUDY TITLE: *SECOND TRIMESTER ANTENATAL UMBILICAL COILING INDEX AND ITS DOPPLER FLOW CHARACTERISTICS AND PERINATAL OUTCOME –PROSPECTIVE STUDY AT TIRUNELVELI MEDICAL COLLEGE HOSPITAL ,TIRUNELVELI.*

STUDY CENTRE: TIRUNELVELI MEDICA COLLEGE HOSPITAL ,TIRUNELVELI

PARTICIPANT NAME : **AGE:** **ID. NO.**

I confirm that I have understood the purpose of the above study.i have the opportunity to ask the question and all my questions and doubts have been answered to my satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving any reason.

I understand that the investigator, regulatory authorities and the ethics committee will not need my permission to look at my health records both in respect to the current study and any further research that may be conducted in relation to it , even if I withdraw from the study. I understand that my identity will not be revealed in any information released to third parties of published, unless as required under the law. I agree not to restrict the use of any or results that arise from the study.

I hereby consent to participate in this study titled *SECOND TRIMESTER ANTENATAL UMBILICAL COILING INDEX AND ITS DOPPLER FLOW CHARACTERISTICS AND PERINATAL OUTCOME –PROSPECTIVE STUDY AT TIRUNELVELI MEDICAL COLLEGE HOSPITAL ,TIRUNELVELI*

Signature of Investigator
Place:
Date:
Study Investigators Name Institution:
Thanking you,
Yours faithfully,
Signature/thumb impression of patient

KEY TO MASTER CHART

CTG – Cardiotocograph
Msl – meconium stained liquor
GA – Gestational Age
IUD – Intra Uterine Death
UCI – Umbilical Coiling Index
AN UCI – Antenatal Umbilical Coiling Index
UmV –Umbilical vein blood flow
N – Normal
AbN – Abnormal
INC-Increased
DEC-Decreased
NVD – Normal Vaginal Delivery
Emer LSCS – Emergency Lower Segment Caesarean Section
F – Female
M – Male
NORMO – Normocoiled
HYPO-Hypocoiled
HYPER-Hypercoiled
SGA –Small for gestational age
LBW-Low birth weight

ABBREVIATIONS
UCI – UMBILICAL CORD COILING INDEX
CTG - CARDIOTOCOGRAPH
NICU – NEONATAL INTENSIVE CARE UNIT
LSCS – LOWER SEGMENT CAESEREAN SECTION
CPD – CEPHALO PELVIC DISPROPORTION
SGA-SMALL FOR GESTATION AGE
LBW –LOW BIRTH WEIGHT